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DESIRABLE SHEEP FOR THE FARM

Three Shropshire ewes—a good breed for mixed farming. Sheep of this general type will clean the weeds out of old pastures and waste land, and if kept by a man who understands his business, their wool will pay all the costs of maintenance, leaving the mutton as clear profit. Young lambs are becoming more valuable each year, and it is impossible for the United States to produce enough in the near future to meet the demand. Cheaper wool and mutton will not be realized until sheep are as common as cows and pigs on the small farms of the United States. Photograph from the U. S. Department of Agriculture. (Frontispiece.)

THE SHEEP COMES BACK

Scarcity of Wool and Mutton, Due to Breaking Up of Open Ranges, May be Remedied by Re-introduction of Sheep into Mixed Farming—Remarkable Demand for Breeding Stock in the United States at Present—Fine-wool Breeds Not Suitable for the Farm.

THAT demand always creates supply is an economic maxim which gets very little support from sheep breeders. Each year mutton and wool grow scarcer, each year buyers are willing to pay a higher price for them, and each year the ranchers raise fewer sheep.

The explanation of this expensive state of affairs must be sought in the world-wide march of civilization. Sheep have always been produced in regions where there was a large area of waste, unfenced land. They have been an accompaniment of the frontier. But the frontier, everywhere, is disappearing. Range land is being cut up for farms. Of the four great sheep countries, Australasia, South America, the United States and South Africa, the latter alone is increasing its sheep range. Broadly speaking, the day of the range sheep is passing. It is, then, an international movement which makes the housewife pay more for smaller lamb-chops, and forces the business man to invest $40 in what was formerly a $30 suit of worsted.

Where is this movement to stop? Will the diner, neatly clad in cotton and wood-fibre, eat his mint sauce on baked beans instead of spring lamb? Probably not, for the law of supply and demand is "coming to," and bringing out a new type of sheep husbandry.

In most countries, sheep have hitherto been grown for wool, with meat as a by-product. The breeds in demand were the fine-wool breeds, evolved by the Spaniards from an oriental stock. These sheep, taken to Mexico from Spain, were secured from Mexico by the western United States, and formed the foundation of the American sheep industry. They cannot be expected, from now on, to be as profitable as "dual purpose" sheep will be.

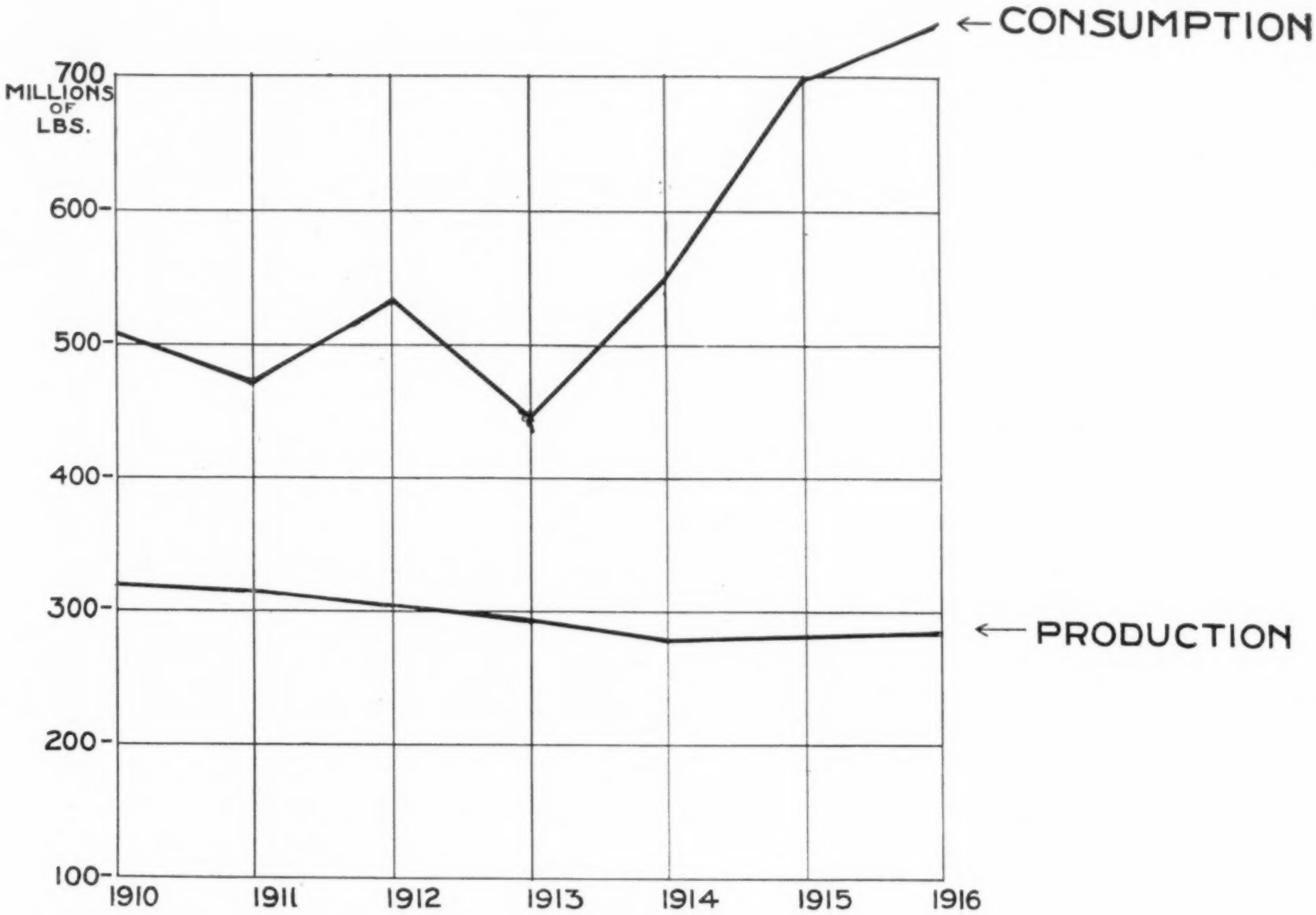
The breed of the future is a breed which combines meat production and wool production in due degree, and which can be raised on the farm as a feature of mixed farming. The Down breeds of England meet this need for the eastern United States; in the West a new breed may have to be created, if it has not been supplied by the hybridizers of New Zealand, in the Corriedale.[1]

SHEEP ON THE FARM

In Great Britain large numbers of sheep are raised on waste land, which is too rocky or unproductive to be plowed. In the United States such land is allowed to lie idle, overgrown with brush, or is perhaps used as pasture for other animals which are able to derive little nourishment from it, not being close-croppers like the sheep, nor able to assimilate so much roughage. The American farmer must be depended on to build up the industry which the American rancher is allowing (willy nilly) to decline. And the American farmer is coming to realize this—coming so rapidly that he has forced the price of breeding ewes up 300% in half a dozen years.

Last year a new homestead act was passed by Congress which will permit applicants in the sheep country to file on 640 acres for grazing purposes. Obviously this means that many of the large ranges will be cut up, and their great flocks of sheep driven out of existence. It was freely predicted that the price of mutton would fall to the ground when the sheepmen began to

[1] See Marshall, F. R. Corriedale Sheep. JOURNAL OF HEREDITY, vii, pp. 88–95, February, 1916.



WHY WOOL IS MORE EXPENSIVE EACH YEAR

The above diagram shows that the production of wool in the United States is slowly diminishing, while the amount of it used is rapidly growing. It is, therefore, inevitable that clothing should be dearer. The situation is aggravated by the fact that the production of wool is decreasing in most other parts of the world, where the large areas that formerly supported flocks of sheep are being plowed under. (Fig. 1.)

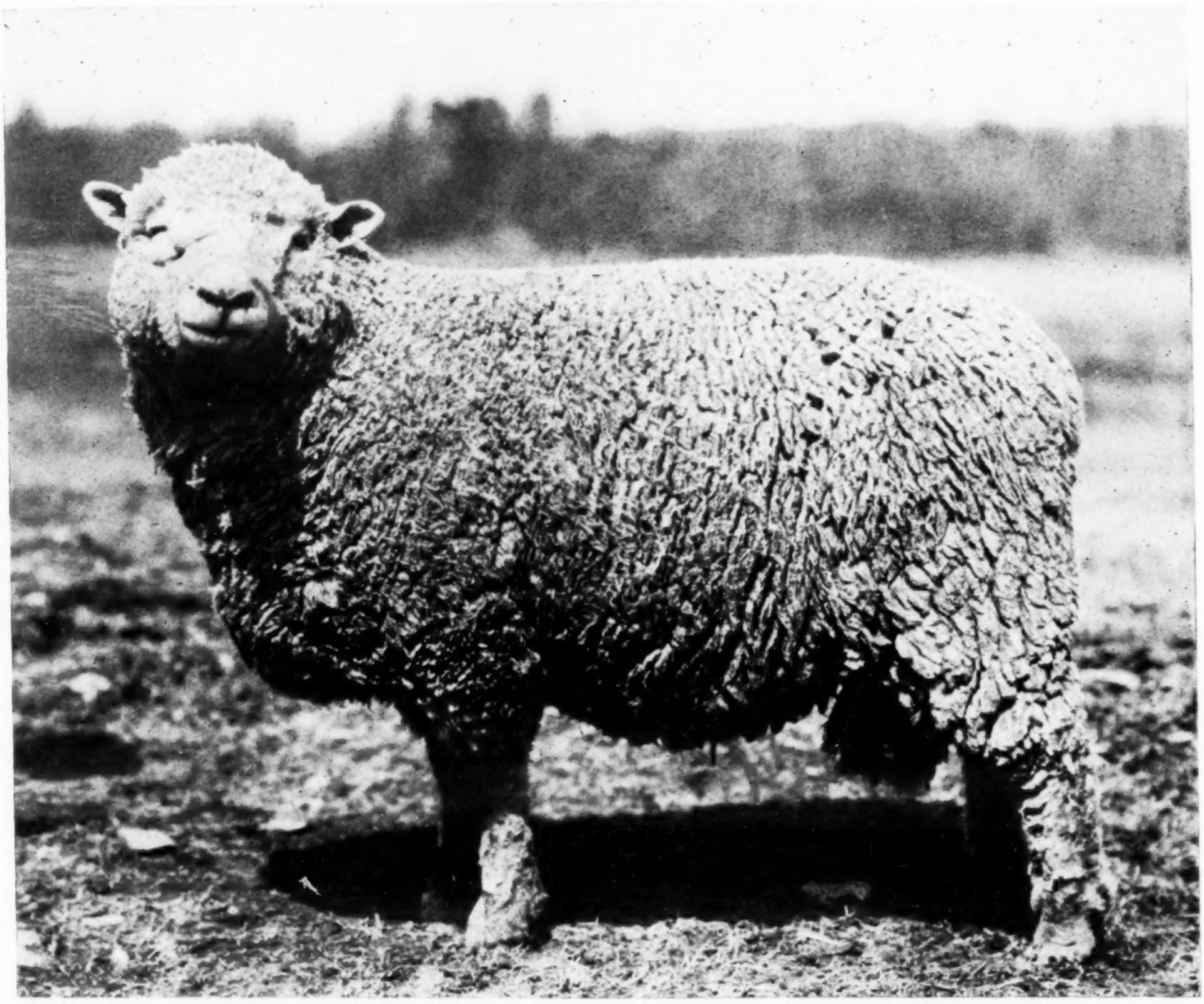
disperse their flocks. But the price has held firm. Many sheepmen, indeed, have been forced to ship their stock east, but it has not reached the stockyards—it was bought up, in large part, by the farmers of the middle west for breeding purposes. The farmers of the east and south have not yet been able to get many sheep, but are ready to buy more as fast as sheep can be grown.

Considering the advantages of sheep on the farm, it seems odd that they should have been universally neglected in the United States, so that only one farm in a dozen has any. The reasons are numerous. Shepherding is a specialized branch of the animal husbandry, which requires skill; few American farmers understand it. Those who did keep sheep confined them to small areas of ground, which in a few years became infested with deadly parasites. And the ubiquitous farmer's dog has always been an enemy of sheep

The first difficulty can be overcome by education in the agricultural colleges. Stomach worms can be avoided if sheep are moved around from one piece of ground to another, after a few years, and if the lambs are marketed early. Dogs can be suppressed. Middle western and other States which are trying to encourage sheep-raising are taking vigorous action against the dog nuisance, and baying the moon may soon become merely a tradition. Iowa has passed a sort of curfew law which provides that owners of dogs must keep them tied up at night, while Illinois has given the sheep raiser authority to shoot any dog he finds on his land, the owner of the dog having no recourse whatever.

THE MOST VALUABLE BREEDS

By such means sheep raising can be reëstablished on American farms. Its



A BREED DEVELOPED BY THE ENGLISH SMALL FARMER

In America and other great sheep countries the favorite breeds have always been the fine wool breeds, such as the Merino. These were bred primarily for wool, and mutton was a side issue. They could be handled profitably only in large flocks on great tracks of cheap land. Such range land is disappearing all over the world now, and the fine-wool sheep is diminishing in numbers as a result. The future of sheep breeding in the United States seems to lie in the dual purpose breeds, particularly the Down breeds evolved in England. The Southdown, a 2-year-old ram of which is shown above, is one of the best of these. Photograph from the U. S. Department of Agriculture. (Fig. 2.)

success will depend largely on the skill of the farmer, and on starting with the right kind of sheep. For this purpose, the English Down breeds—Shropshire, Hampshire, Southdown, Dorset and Oxford—and the Tunis breed are desirable. Merinos, the finewool sheep of the western plains, are less desirable for this purpose; if kept, they should be mated with a black-face ram. If he understands what he is doing, the farmer should make the meat pay the entire expense of maintaining the sheep, leaving the wool as clear profit.[2] No other animal, it is claimed, can be handled with as little labor and expense, and as large returns in proportion to the investment.

One of the incidental advantages which may be of great value is the destruction of weeds. In some of the eastern States, a large part of the pasture

[2] Lambs are now worth about $13 per hundredweight "on the hoof." Clipped wool brings from 50 to 70 cents a pound, and an average sheep yields 8 pounds a year. The number of sheep over one year old in the United States is about 35,000,000 and the annual slaughter about 13,000,000.

AFTER THE CLIP

To the untrained eye, a sheep is not under any circumstances a beautiful animal, unless when seen at a distance as part of a landscape. But the sheep which has just been shorn is, perhaps, even less attractive, esthetically, than one in the fleece. The sacrifice is financially well worth while, however, for an average sheep will yield 8 pounds of wool a year, which now brings the extraordinary price of 50 to 70 cents a pound. The animal above is a yearling Southdown ram. Photograph from the U. S. Department of Agriculture. (Fig. 3.)

land has degenerated and is so grown up with weeds as to be practically worthless. By ordinary methods this can not be reclaimed profitably. But a flock of sheep will clean up the weeds and grow fat on them, and the blue-grass will follow in their footsteps. The intelligent farmer who starts with even a dozen ewes and allows them to reclaim his waste land will make money. "Sheep stand alone," says F. R. Marshall,[3] "in their ability to yield a quickly-made, marketable article from a maximum of forages. In a single season they can harvest and economically use two immature crops from the same land that ordinarily produces but one seed crop. By manufacturing the plants into meat and wool before they make their greatest draft upon the fertilizing elements of the soil, and by returning thereto the greater part of those elements, the forage-raised sheep are invaluable as conservers of soil fertility and indispensable occupants of land deteriorated or in danger of deterioration by grain-raising."

In short, "the mutton sheep is the most economical of animals for conditions of intensive stock farming."

[3] In an address before the Second Pan-American Scientific Congress.

A HERD OF SHEEP CLEANING UP AN OLD PASTURE

In some of the older States of the Union, much of the pasture land has deteriorated until it has become almost worthless, producing little but weeds. A small flock of sheep will fatten on the weeds, and bluegrass will follow in their footsteps. Even a dozen sheep, properly handled and moved to fresh land every year or two, will be a valuable asset on a farm. The view here shown is in North Carolina. Photograph from the U. S. Department of Agriculture. (Fig. 4.)

The present sensational "boom" in the sheep industry is, therefore, an increase in national assets. Besides furnishing the necessary mutton and wool, it will have several indirect advantages:

1. It will diminish the amount of grain and expensive concentrates fed for livestock, thus leaving more food for the human population.

2. It will reclaim or increase the value of millions of acres that are now lying idle or, as pasturage, are giving little income.

3. It will help to diminish the serious shortage of farm labor, since sheep require less labor than any other important branch of animal husbandry.

THE QUESTION OF PRICES

But will the price of mutton and wool drop?

Probably not in the near future. Meat is in too much demand, and the number of lambs marketed is likely to diminish, as the ewes will be sold for breeding instead of butchering.

The wool market is pretty certain to show a further rise, instead of a fall, until some time after the war. The amount of wool needed for military purposes in the United States is estimated to be equal to an entire year's clip of this country. It is a long time since the United States produced enough wool for its own needs. Imports have been getting heavier each year. As a war measure the British Government placed an embargo on wool exports from its colonies. Although this was raised under certain limitations for some American manufacturers, it left South America the only large, free market, and here great quantities of wool were bought up and stored by Germans, to keep it from reaching their enemies.

From the day America entered the war, it was evident that, in the ordinary

GOOD AND POOR MUTTON TYPES

A valuable leg of mutton can be secured from the ewe at the left, while the one at the right, although costing as much to keep, will yield much less meat. The ewe on the left is of the Southdown breed, one of the best for the small farm. Photograph from the U. S. Department of Agriculture. (Fig. 5.)

course of events, wool would become dearer in the United States. Early in April, a committee of wool merchants, inspired by patriotism, offered to allow the Army to contract for all the woolen cloth it wanted at the then ruling market price. The offer was not accepted; and when, several months later, contracts were finally let for woolen goods it was necessary to pay the current price, which had in the meantime advanced 30%.

The Navy endeavored to avoid "bulling" the market by contracting for as much wool as it needed in Australasia, and offering to deliver it to American manufacturers, to be turned into cloth at a fair profit. The arrangement seems to have worked well.

But nothing is likely to prevent further increase of the cost of wool; and it is noteworthy that clothing manufacturers are among those who are trying most actively to stimulate sheep-raising, in some of the middle western States. They reason that if woolens become

ONE DRAWBACK TO THE SHEEP INDUSTRY

Dogs have always been an enemy of sheep, and have made the industry unprofitable in many regions. But with the present "boom" in sheep breeding, many States are trying to end this nuisance. Illinois now gives the farmer the right to shoot any dog he finds on his land without asking any questions. With extension of such legislation, scenes like the above, showing the result of a night's carnival by the neighbor's dogs, will no longer be possible. Photograph from the U. S. Department of Agriculture. (Fig. 6.)

much more costly, men will not buy new suits so frequently, and the clothing industry will, therefore, suffer.

Besides the clothiers, so many other interests will be benefited by a more widespread sheep industry, that a "boom" is not surprising. If it is guided wisely, it should make the sheep as much a feature of mixed farming as is the cow, pig, or hen.

Studies in Animal Behavior

STUDIES IN ANIMAL BEHAVIOR, by S. J. Holmes, Ph.D., associate professor of zoölogy, University of California. Pp. 266. Boston, Richard G. Badger Co., 1916.

The manifestations of instinct and intelligence in animals have a widespread interest, but popular accounts are likely to be highly unscientific; and this is even more true of popular accounts of the evolution of intelligence. So scholarly and readable a volume as that of Dr. Holmes is therefore of particular value. He surveys a wide field, from detailed studies of tropisms to the evolution of parental care, the recognition of sex, and "the mind of a monkey." Instinct is universal among animals but intelligence, which he defines as "the power of forming associations, or associative memory" has its beginnings very far down in the scale, and is a development of instinct. No matter how much developed the intelligence is, instinct still furnishes the fundamental springs of action, even in man.

THE YOUNG MOTHER

Alexander Graham Bell's Investigation Shows Her Age Has a Marked Effect on the Vitality of Her Children—Infant Mortality Increases Steadily as the Mother Grows Older—From This Point of View Girls Ought not to Delay Marriage beyond the Age of Twenty-five

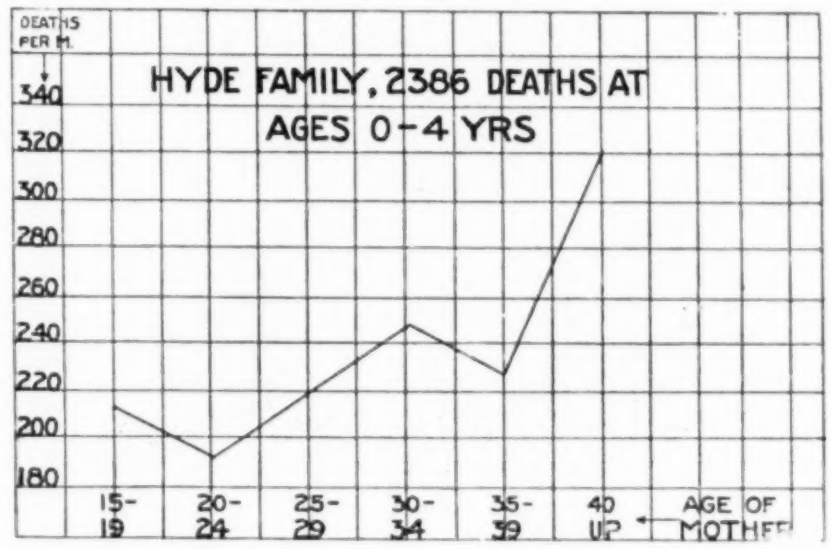
THERE is a growing tendency among women of the most intellectual type to postpone the age of marriage and motherhood. Whereas most women marry between 20 and 25, graduates of women's colleges most frequently marry between 25 and 30. Miss M. R. Smith calculated[1] the average age at which college alumnae wed, as 26.3 years. This means that to offset the considerable number who marry as soon as they graduate, there are many who do not marry until the age of 30 or after.

Feminists without adequate scientific training have attempted to justify this course, and have tried to create an impression that the children of young mothers are in some way inferior, while the best children are those born to women who have reached a certain maturity. In much of the recent periodical literature due to radical feminists, there is a tendency to suggest, if not to declare, that it is to the advantage of both mother and child that women should not undertake the duties of maternity too early.

TABLE 1

Age of mother when child was born	*Total No. of children born*	*No. who died under 5 years of age*	*Child mortality, rate per thousand*
15–19	70	15	214
20–24	454	88	194
25–29	603	133	220
30–34	561	140	249
35–39	422	98	232
40 and upward	274	88	321
Total.....	2,384	564	

Whether or not there are social reasons that make late marriage desirable for girls, will not here be discussed. But as for biology, every eugenist knows of the abundant proof that relatively early marriage is beneficial both to mother and to child.[2] One of the proofs is furnished by a study of infant mortality in relation to age of mother.



INFLUENCE OF MOTHER'S AGE

Those children show the greatest vitality who were born to mothers between the ages of twenty and twenty-five. Children born after the latter age are increasingly penalized. The total of 2,386 is erroneous; it should be read 2,384. (Fig. 7.)

Alexander Graham Bell has recently completed an investigation of the longevity of members of the Hyde family in the United States.[3] They represent an intelligent, prosperous, old American stock; most of the births in the genealogy fall between 1750 and 1825. Table I and Fig. 7 show the child mortality and the age of mother when the child was born. In general, it is evident that a child's chance to survive the diseases

[1] *Quarterly Publications of the American Statistical Association*, March-June, 1900. Miss Smith noted that marriages under twenty-one were becoming more frequent among noncollege women, while marriages after thirty-four were growing in number among college graduates.

[2] A large amount of evidence from European sources was published by Corrado Gini in Vol. ii of Problems in Eugenics (London, 1913).

[3] These data are published in Vol. ix of the *Beinn Bhreagh Recorder*, a copy of which is on file at the Smithsonian Institution, Washington.

and dangers of the first four years depends quite directly on the age of its mother. The death rate for children of the oldest group of mothers is about 50% greater than that of the children of young mothers.

The mothers under 20 years of age appear to form an exception. At first sight, the higher death rate of their children seems to indicate clearly that too early maternity is a disadvantage. Without denying this possibility there are several considerations which make it seem probable that these youngest mothers form an exception more apparent than real to the general biological rule: the younger the mother, the better the child's chance. It is possible that the higher death rate in the children of this group is partly due to the juvenility and inexperience of the mothers, and not to their physical unfitness for marriage. This explanation cannot be pushed any farther, as has sometimes been done, to claim that all infantile mortality depends more on the intelligence and training of the mother than on her age; for in such a case the death rate ought to be lower with each added year of the mother's age—a supposition exactly contrary to fact. The higher death rate in this first group may also be due in part to the fact that the children involved are practically all first-born, for whom the death rate is well-known to be higher than for those who immediately follow them. In the other groups of mothers, the first-born children are swamped by the later-born, and the effect of their presence is not so evident as for the group of mothers 15–19, practically all of whose children must be first-born. This is a biological matter, but not one which offers any reason for postponing maternity; since if a woman is going to have children at all, one of them must be first-born.

If these two suppositions are well founded, then the death rate of children born to mothers 15–19 does not necessarily prove, at least to such an extent as one might think, that the mothers were physiologically too young when they married.

The other facts in the table are self-explanatory. While the evidence cannot be considered wholly satisfactory, until data are available which take account of the order of birth of the children, and the intervals between births, as well as the age of the mother at birth, yet the general conclusion to be drawn is clear. The children of young mothers have the greatest vitality, and every added year of the mother's life is a handicap to her next child.

TABLE II

Mortality Rate per 1,000 *Births among Infants Included in Three Investigations, Classified According to the Age of Their Mothers*

Age of the mother	*Number of births*	*Infant mortality rate*
Boston (Mass.) Investigation		
All ages	2,025	125
Under 21 years	145	90
21 to 25 years	559	109
26 to 30 years	573	131
31 to 35 years	440	132
36 to 40 years	241	149
Over 40 years	67	164
Fall River (Mass.) Investigation		
All ages	746	202
Under 20 years	29	103
20 to 29 years	386	189
30 to 39 years	257	206
40 and over	36	222
Unknown	38	...
Johnstown (Pa.) Investigation		
All ages	1,463	134
Under 20 years	95	137
20 to 24 years	454	121
25 to 29 years	391	143
30 to 39 years	449	136
40 years and over	74	149

There is plenty of confirmatory evidence. Three studies of infant mortality in America[4] are presented in Table II. For comparison with Table I, it should be noted that these tables deal only with the first year of the child's life, while

[4] The Boston study was made by Hibbs and others of the Boston School for Social Workers, in 1910–12, and is quoted from Hibbs, Henry H., Jr., Infant Mortality. New York, Russell Sage Foundation, 1916. The other two tables are cited from Hibbs after:

Dublin, Louis I. Infant Mortality in Fall River, Massachusetts. *Quarterly Publications of the American Statistical Association*, n. s., No. 110, June 1915.

U. S. Children's Bureau. Infant Mortality: Johnsontown, Pa. Washington, 1915.

Alexander Graham Bell's study carried the child through the first four years. The general trend of the evidence is the same in all cases, and in two of them the mothers under twenty make a better showing than any others. Differences in race and social status in various cities are so great that any exact comparison would be unprofitable. It is only desired here to insist on the uniform trend of the statistics, which indicate very clearly one of the dangers of delayed marriage.

The uniform trend of the data precludes the idea that the death rate is more influenced by the mother's intelligence than her age. It might be, however, that it is largely influenced by poverty. In this view the young mothers would succeed better with their children because they had only a few to care for; while the mothers at the age of 35 to 40 had already large families and too little income to provide the new arrivals with the necessary care. This argument doubtless holds good to some extent in the slums, but it can hardly carry much weight in the Hyde family, which seems on the whole to have been fairly well-to-do. If both these influences (increasing experience and poverty of mother with added age) were at work, they would tend to neutralize each other, thus leaving the actual results to be attributed to physiological factors connected with the age of the mother.

In sum, it seems clear that the age of the mother at the birth of her children has a marked influence on their vitality; that as measured by infant mortality the best age for a girl to marry is probably between 20 and 25; and that every year a woman delays childbearing after the age of 25 is penalizing her children.

The Manchu Emperor K'ang Hsi as a Plant-Breeder

One of the earliest examples of successful breeding of a pure line, that is, a uniform strain descended from a single plant, appears to be furnished by the Manchu emperor K'ang Hsi, who reigned 1662–1723. The story (which, of course, requires authentication) is translated by E. R. Huc from the emperor's own memoirs, as follows:

"I was walking, on the first day of the sixth month, through some fields where rice had been sown which was not expected to mature until the ninth month. I noticed, accidentally, one rice plant which had already headed out. It was much taller than any of the others and was sufficiently ripe to be plucked; I had it brought to me. The grain of this head was well formed and developed; this gave me the idea of saving it and planting it, in order to see if it would retain its precocity the following year; in effect, it did retain it. All the heads which appeared ripened before the usual time and were ready for harvest by the sixth month. Every year has multiplied the produce of the preceding year, and for thirty years it is the rice which has been served on my table. Its kernel is elongated, and slightly reddish in color; but it is of a delightful odor, and of a very agreeable savor. It has been named 'yu-mi,' imperial rice, since it was first cultivated in my gardens. It is the only variety which will ripen north of the great wall, where the cold stays late and comes extremely early; and in the south, where the climate is more mild and the ground more fertile, two crops a year are easily raised. It is indeed a sweet consolation to me thus to have procured this advantage for my people."

Huc (*L'Empire Chinois, t. ii*) further states that the rice is particularly adapted to semi-arid regions. This variety of rice, if it exists, has apparently not been introduced to America. Cereal experts have heard of a Manchurian rice which corresponds in many ways to K'ang Hsi's description, but it is held in such esteem by its growers that they have been unwilling to part with any seed.

ANCESTRY OF THE CAT

Tabby an Animal of Mixed Blood—Egyptian Wild Cat Probably First Domesticated and Has Crossed with Other Cats in Many Lands to Which It Was Taken by the Phoenicians

ALTHOUGH the popular opinion supposes the house cat to be simply a domesticated European wildcat (*Felis catus*), which formerly inhabited all of Britain and ranged over the continent from Greece to Scandinavia, it seems probable that "tabby" cannot trace its descent entirely from one wild species. The breeding, selection and domestication of the cat have been the object of much thought for thousands of years.

The probable ancestor of most domestic cats is a yellowish cat with tiger stripes, *Felis libyca*, which still roams about Northeastern Africa, hunting mostly at night and living in holes dug by other animals.[1] The African cat is but slightly larger than the domestic cat, and often marked quite similarly, although the coloring is usually lighter and more tiger-like than that of the "tabby." There is no more differentiation, however, than often appears between house cats living in the same block of a city street.

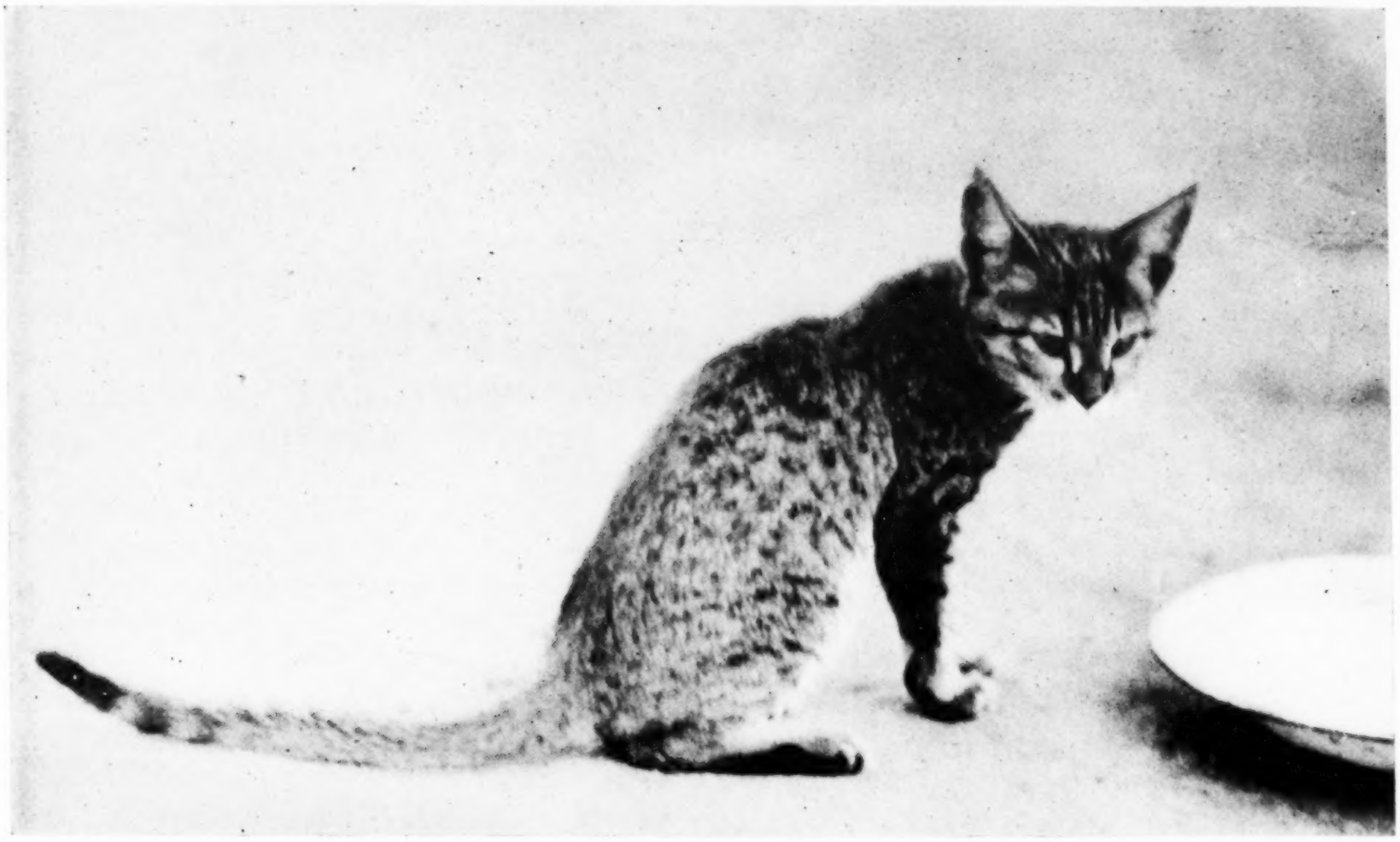
Some thousands of years before the advent of the Christian era, Egypt was a land of storehouses overflowing with the rich produce of the fertile Nile valley. Rats and other rodents found no food so available and no shelter so safe as that furnished by the Egyptian granaries. It is probable that the first attempts at domestication of the cat occurred when specimens of *Felis libyca*, which abounded in the region, were caught and locked up in the grain houses to catch vermin.

Appreciating the importance of such a protection to the produce of the land, the wily priests soon established the cat as a sacred animal, which was to receive every attention from the totemistic inhabitants. Temples sprang up in honor of the cat-goddess Pasht, from whose name some think the word "puss" is derived, and cats were mummified with as much ceremony as were men and women. The members of a family which lost a cat by death shaved their eyebrows and went into deep mourning. A cemetery was recently discovered at Bubastis which yielded several hundred thousand cat mummies, many of them preserved with elaborate care. The present inhabitants of the country took sufficient interest in the feline remains to dispose of them as fertilizer at $15 per ton.

Perhaps the next nation to become interested in the newly domesticated animal was Phoenicia. The hardy seafarers must have been greatly troubled with rats aboard their ships, and found the cats a help in protecting the pantry. In their travels the Phoenicians evidently took the Egyptian cats to all parts of the then known world, so that many species of wildcats now existing along the Phoenician trade route are believed to be the feral descendants, either direct or crossed with indigenous cats of the locality, of the Phoenician rat-killers.

The Greeks probably had no cats. The *ailuros* which they kept on board their ships for killing rats seems to have been the white-breasted martin (Mustela), although the word "cat" is frequently though erroneously used in translating the Greek term. But the Romans evidently possessed them, and it is probable that from Rome they

[1] This cat is also known under the names of *F. caffra*, *F. obscura*, *F. nigripes*, *F. maniculata*, *F. pulchella*, *F. chaus*, *F. caligata*, *F. margarita*, *F. inconspicua*, *Chaus caffer*, *Leopardus inconspicuus*, etc. The above names are sometimes applied to other cats than the Egyptian wildcat, but since all the small wildcats interbreed freely, it is difficult to draw any line in nomenclature. The house cat passes everywhere under the name of *F. domestica*.



THE ANCESTOR OF THE HOUSE CAT

Although the common house-cat of Europe and America is very much of a mongrel, its pedigree can always be traced back to a wild African cat, a specimen of which is shown above. This one, which is only half-grown, was kept as a pet by natives of the northeastern Uele district, Belgian Congo, and was photographed by Herbert O. Lang, of the Congo Expedition, American Museum of Natural History (New York City). It is supposed that this species was first domesticated by the Egyptians and then secured by the Phoenicians, who are thought to have taken it with them on their travels and thus dispersed it very widely. (Fig. 8.)

were carried northward. As soon as the domestic breed became established in Europe it began to cross and still does cross freely with the European wildcat (*Felis catus*). It is probable that the cat was brought by the Romans to Britain some time before the fifth century, although the first mention of its existence occurs in the laws of the Welsh prince Howel Dhu, which were enacted about the middle of the tenth century. It seems possible that the European wildcat and Egyptian cat were of much closer relationship than has been supposed, since fossil feline remains found in Britain bear just as much resemblance to the Egyptian cat as they do to the native wildcat of the present day.

From the crossing of the imported Roman cats and the British wild cat evidently resulted the modern "tabby." But the Angora comes from another source. Just what this source was is not positively known, but it seems probable that a cat of Central Asia (*F. manul*), popularly known as Pallas' cat,[2] is the ancestor of the Angora and

[2] Peter Simon Pallas, 1741–1811, was a German by birth and parentage, but did practically all his notable work in Russia and is hence often classed as a Russian naturalist. He was the son of a surgeon in the Prussian Army and himself studied medicine, but early developed a bent for natural history and at 23 years of age was made a foreign member of the Royal Society. By personal invitation from the empress, Catharine II, he occupied the chair of Natural History at the Imperial Academy of Science in St. Petersburg. He spent a year in England studying geologic conditions there, and was then appointed naturalist to a Russian scientific party which made a trip through Russia and Siberia. During the six-year trip he went by Kasan to the Caspian Sea, spent some time among the Kalmucks, crossed the Urals to Tobolsk, visited the Altai Mountains, traced the Irtesh to Kolyvan, went to Tomsk and Yenisei, crossed Lake Baikal, and explored the frontiers of China. His records of this trip form one of the most interesting chapters in natural history. He was given a magnificent estate in Crimea by the empress on his return, where he lived until the death of his second wife, then removing to Berlin, where he spent the last year of his life.

Persian breeds of today. Pallas' cat has long, soft fur of a light whitish-grey color, and a short ringed tail, and is slightly smaller than the Egyptian cat. It may be supposed that careful crossing and selection lightened the color of the hair still further, and eliminated the conspicuous rings from the tail.

In every country to which the Egyptian cats were taken, crossing probably took place between the newcomer and the indigenous cats already inhabiting the locality. A great number of variations would thus be continually produced, and hence the domestic cat is, properly speaking, not a true species but a "convergent species" or an aggregate of crosses between the Egyptian cat carried by the Phoenicians and the wild cats of every country where the Egyptian cat was taken. This accounts in part for the wide variation to be seen among modern cats. The rest of the variation seems to be due to mutations.

But We Are Not Yet Devoid of Hope and Cheer

THE FURTHER EVOLUTION OF MAN, a study from observed phenomena, by W. Hall Calvert, M.D. Pp. 324. London and New York: Fleming H. Revell Co., n.d.

"The palmy days of heredity are over," says Dr. Calvert. Its "dead hand" can no longer restrain the progress of what he calls "genus homo sapiens." The idea of natural selection Dr. Calvert has likewise "absolutely confuted: and it is fortunate for the race that this awful doctrine has been destroyed, otherwise the only possible fate of man was one of despair and devoid of hope and cheer."

But Dr. Calvert (who owes many of his ideas to "association with the fine intellectual vigor and acumen of the minds of the Shakespeare Club of Melrose") is not the man to tear down a noisome hovel without erecting in its place a splendid temple, four-square to all the winds that blow. He recognizes that there must be some check on the increase of population; what is it if not natural selection? What else but "Paulin's law of the cannibal habit of the male"? The reason that the numbers of a species do not perceptibly increase is because the father eats the surplus offspring as fast as they are produced. This accounts for the stability of species among the carnivora and also, Dr. Calvert declares, in that class of animals which shortsighted naturalists have been calling herbivora; but it does not apply to "genus homo sapiens;" and the author takes this occasion to point out to men of so-called science the folly of trying, as they do, to make one explanation fit too many cases. The check on increase of human population is something quite different,namely, the supposed fact that a man does not marry if he is out of a job.

So much for the "now exploded hypothesis" of Darwin and Malthus. It follows that the "survival of the fittest" is a delusion; instead there is the "survival of the average," due to the supposed swamping effects of sexual reproduction on any new character. All that an animal inherits is the general species-heredity; everything else is due to the environment. It passes belief that professed scientists should have failed to recognize the importance of the environment, when "all the religious bodies of the world understand the power which environment gives them in maintaining and increasing the numbers of their respective creeds"!

From this point "we are carried back, through the force of pure reason, to the argument of design, having its origin in a great First Cause, which alone has given laws to matter, method to the universe, and life upon the earth."

The progress of science requires that all its doctrines, such as natural selection, should receive constantly the most severe criticism possible. But it is rarely nowadays that a reputable publishing house issues a treatise on evolution by a man who knows as little about evolution as does Dr. Calvert.

THE PARENTS OF GREAT MEN

Report on Data Submitted in Response to Offers of C. L. Redfield—Hypothesis that Talent Is Inherited only as a Result of Excess Work Done by Ancestors Is Not Supported by Facts

IT IS the general belief of men of science that parents cannot transmit their education to their children, by the process of biological heredity. The child is the product of the parents' germ-plasm, and no way is known by which the reading and study of the parents could so affect their germ-plasm as to change the mental capacities of their offspring. The child, it is supposed, inherits only the inborn, germinal traits of his father and mother, and is unaffected by those which his parents acquired, whether they be physical, as scars or sunburn, or mental, as a knowledge of Sanskrit.

But this general belief is not accepted by C. L. Redfield, a Chicago engineer. He is convinced that

> Educating the grandfather helps to make the grandson a superior person. . . . We are, in our inheritance, exactly what our ancestors made us by the work they performed before reproducing. Whether our descendants are to be better or worse than we are will depend upon the amount and kind of work we do before we produce them.

Mr. Redfield reached this conclusion through the study of pedigrees of men and various other animals, which seemed to show that superior individuals were always born late in the life of their parents, or at least, that they represented several generations of slow breeding. He reasoned that this excess time must mean that the parents had done excess work before reproducing, and that the offspring were superior because they inherited the effects of this excess work.

A theory so antagonistic to the accepted view of heredity naturally made little headway among biologists. With a view to securing evidence which might be more convincing, Mr. Redfield asked the American Genetic Association to publish an offer on his behalf, and this offer has been open for about three years. As revised and expanded a year ago,[1] it read as follows:

1. He will pay $200 for evidence that any one of the two or three thousand intellectually great men or women of history is the product of an ancestry which represents, on the average, four generations to a century.
2. He will pay $200 for evidence that any one of the two or three hundred intellectually *very* great men or women of history is the product of an ancestry which represents, on the average, three generations to a century.
3. He will pay $200 for a case from livestock breeding, where the parents made acquirements below the standard, in respect to performance, and the offspring surpassed the parents.
4. He will pay $200 for a case where a decline in powers of the offspring failed to follow acquirements, in the parents, which were clearly and distinctly below the standard of performance of the breed.
5. He will pay $200 if it can be shown for any group of animals that the amount of improvement or decline in animal powers was not, as nearly as can be determined by actual measurements, exactly proportional to the amount of acquirement by ancestors above or below the normal or standard.

This offer expired on December 31, 1916, and the results are presented herewith.

NO COMPLETE HUMAN PEDIGREES FOUND

A number of pedigrees of great men have been submitted, which show rapid breeding; but none of these is complete to the extent of including all ancestors for three generations. Thus none of them meets Mr. Redfield's requirement.

[1] JOURNAL OF HEREDITY, vii, p. 286. Previous articles dealing with the subject are in this JOURNAL, Vol. vi, p. 157, p. 249, p. 254, p. 487; Vol. v, p. 316

This failure is not due to the lack of diligence on the part of correspondents,[2] some of whom have devoted much time to the study; but to the inadequate genealogical material available about great men. It is a noteworthy fact that Mr. Redfield himself, who has published hundreds of fragmentary pedigrees of great men, showing rapid or slow breeding, has not in a single instance, so far as the writer knows, published a complete pedigree for three generations, such as his offer required.

While none of the pedigrees was technically acceptable, in competition for Mr. Redfield's money, some of them are of interest.

ABRAHAM LINCOLN

The ancestry of Abraham Lincoln was long shrouded in doubt, to such an extent that his birth was widely alleged to have been illegitimate. The supposed inferior character of his forebears has long been a stock case for citation by those who "don't believe in heredity," and who pointed to Lincoln as a great man who had come from a most unpromising stock, in defiance of all the laws of inheritance of mental qualities. Mr. Redfield, misled by inaccurate accounts, has cited Lincoln as the product of exceptionally slow breeding, and would account for his preëminence in this way.

But recent researches[3] have taken all the mystery from Lincoln's parentage and shown, as Ida M. Tarbell puts it, that he "inherited from his ancestry traits and qualities of mind which made him a remarkable child and a young man of unusual promise and power. So far from his later career being unaccounted for in his origin and early history, it is as fully accounted for as is the case of any man." The Lincoln family was one of the best in the United States, and its men had made a uniformly good record, in various parts of the country, for nearly two hundred years prior to his birth. His father, Thomas Lincoln, while eccentric, was a man of remarkable character in many ways, by no means "poor white trash" as popular tradition describes him. The family of Nancy Hanks, Abraham's mother, was likewise one which showed a high level of mental and moral qualities. Moreover, Thomas Lincoln and Nancy Hanks were cousins. Miss Tarbell is quite right in saying that Lincoln's abilities were the natural product of his ancestry.

While the names of all his ancestors on both sides, for four generations, are known, many of the dates are uncertain and it is impossible to say definitely to what extent reproduction in this family was earlier or later than usual. Thomas Lincoln was thirty-one and Nancy Hanks twenty-five, at the time Abraham was born, both these ages being under the average for old American families. It is known that Samuel Lincoln, Abraham's ancestor of the sixth remove, was born in 1620; hence for this one line of descent, the "tail-male,"[4] the average of six generations is 31.5 years, well below the average of mediocrity, whereas on Mr. Redfield's hypothesis it might have been expected to be above. The case of Lincoln, while not complete enough to bear much weight, is as far as it goes opposed to Mr. Redfield's hypothesis.

The exact determination of an average[5] length of generation is naturally

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[2] Thanks are due to the following, for their research: E. N. Bacon, Chelsea, Vt.; Dr. Anna E. Blount, Oak Park, Ill.; Dr. J. G. B. Bulloch, Washington, D. C.; J. Clarke, Leonia, N. J.; H. L. F. Gillespie, Manchester, Iowa; Dr. Heinrich C. Keidel, Columbus, Ohio; Marshall Nevers, Brooklyn, N. Y.; Dr. A. J. Rosanoff, Kings Park, L. I.; Elizabeth A. Sourdry, St. Louis, Mo.; W. I. Varner, Athens, Ga.

[3] Tarbell, Ida M. *The Early Life of Abraham Lincoln.* New York, 1896. Hitchcock, Caroline Hanks. *Nancy Hanks.* New York, 1899.

[4] From the genealogies of New England families, Mr. Redfield calculates the average length of one generation to be 33.83 years; of two generations, 65.26 years; of three generations, 96.5 years. The "tail-male" is the line of straight descent from father to son: in human pedigrees it is the line that bears the family name.

[5] An average is often merely a device for obscuring the truth, and in any serious study it is necessary to know the deviations from the average as well. Sufficient attention has never been given to the problem of determining the length of a human generation in various countries; it might well occupy the time of some unemployed statistician.

the first step to be taken in this discussion, and one to which Mr. Redfield has not given sufficient attention. He has calculated the length of *paternal* generation in old American families as 33.83 years, and given this universal application. The average of the generations of the two sexes is the correct measure for this purpose. From a more extensive compilation of data by Alexander Graham Bell, on marriages in the Hyde family of America,[6] the length of a paternal generation appears to be 35.4 years and of a maternal generation 33.1 years, giving an average for the two sexes of 33.2 years. By whatever standard, Lincoln's ancestry, as far as known, is found to represent rapid breeding.

FREDERICK II, "THE GREAT"

Frederick the Great of Prussia was born in 1712 when his father was 24 and his mother 25 years old. The ages of his four grandparents were 31, 20, 27 and 21, a remarkable record. His four great-grandfathers furnish the ages 37, 39, 31, 42. His great-grandmothers have not been mentioned by any of the correspondents; if their ages were learned they might easily be found low enough to bring the whole pedigree within the scope of Mr. Redfield's offer. Frederick the Great was admittedly a man of remarkable talents but as his pedigree was not submitted in a complete form, this association is spared the embarrassment of trying to decide exactly how great he was. He remains, nevertheless, as a real difficulty for Mr. Redfield's hypothesis.

WILHELM II, "THE GOOD"

The pedigree of William II, the present Kaiser of Germany, is the most complete received. It lacks only one great-grandmother of being complete for three generations, and shows a remarkable record of rapid breeding. If it be supposed that this missing grandmother was of the same age as her husband (she is more likely to have been younger than older), the average length of the three generations in Wilhelm's ancestry is only seventy-nine years. What an exceptional record this is, can only be appreciated by genealogists who have sought other cases where three generations were compressed within so short a span of years. It would be hard to duplicate. Considering Wilhelm's present position on the world's stage, it is fortunate that the missing great-grandmother relieves this Association from the necessity of deciding how great a man he is. His admirers may look on him as a striking refutation of Mr. Redfield; his despisers will take the opposite view. As Wilhelm married young, the case may be made still more striking by extending the genealogy to his son, the present Crown Prince.

Various figures indicate that the average length of a generation in Prussia is considerably greater than it is in New England. The average age at marriage is given by Mulhall (Dict. of Statistics) as 29.7 for men and 27.1 for women. It is generally calculated by those who deal with vital statistics that the average mother is six years older than the average bride.[7] From this it follows that the average generation in Prussia must be 34 or 35 years, while Frederick's ancestry represents generations of less than twenty-nine years, and Wilhelm's probably about twenty-six.

A careful study made on Mannheim families gives even higher results than the above. Professor Schott[8] took 4,000 families who existed in Mannheim at the beginning of the nineteenth century, and followed them down to the beginning of the twentieth. He found the average difference between the age of a man and his eldest son was 33¼ years, between a man and his eldest grandson, 66⅔ years, between a man and his

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[6] Dr. Bell's data are presented in the *Beinn Bhreagh Recorder*, Vol. xix, June 12, 1916. The editor of the JOURNAL OF HEREDITY is alone responsible for the calculation given above.

[7] This holds good in Great Britain and Sweden. In the Hyde family the difference is seven years.

[8] Schott, S. Alte Mannheimer Familien, ein Beitrag zur Familienstatistik des 19. Jahrhunderts. Mannheim und Leipzig, 1910. J. Bensheimer.

eldest great-grandson, 95⅓ years. Knowing the age of the father when his eldest son was born, one can reach an estimate of the father's age at marriage by deducting two years from the age first given. This puts the average age of marriage of men in Mannheim at 31¼ years: the actual figures would be under rather than over this. Adding six years in accordance with custom, it appears that the length of a generation in the male line in Mannheim cannot be much less than thirty-seven years.

HERBERT SPENCER

Herbert Spencer was born in 1820, when his father was 30 and his mother 26. His father's ancestry shows a record of rapid reproduction, five generations of the tail-male averaging only 29 years each. In the mother's ancestry, according to Mr. Redfield, there is indication of slow breeding.

The average generation in England appears to be at least a year shorter than in Prussia.

JOHN STUART MILL

Few of John Stuart Mill's ancestors are known, but his case is worth quoting, because it is great thinkers like Mill and Spencer who, one would suppose, ought to show the most clear-cut evidence for Mr. Redfield's hypothesis, if it were well-founded. Mill was born in 1806 when his father was 33 and mother 24. His father was an eldest son, and his paternal grandmother was the daughter of an 18-year-old girl.

WILLIAM "THE CONQUEROR"

The pedigree of the Norman dukes is incomplete, but it is known that Richard I, "Sans Peur," was born in 933, and that William was born in 1027. This gives 94 years for three generations in the tail-male, a length of time which is below the average for even persons of mediocre intellect.

LOUIS PASTEUR

The length of an average generation in France has been frequently investigated. In Paris of the eighteenth century Fourier and Villot, working independently, found it to be about 33 years for men and 28 for women. Wacher (1882) reached figures two years higher than these. Turquan[9] made a very careful study in 1892, which fixed the generation at that time as 34.8 years in the male line and 29.8 in the female, giving an average generation of 32.3 years.

If a body of thoughtful persons were asked to name the greatest man France has ever produced, Louis Pasteur would probably get more votes than any other. If it were a body of *very* thoughtful persons, the vote would probably be unanimous. Pasteur's ancestry[10] is therefore well worth study.

Born in 1822, he came of a humble stock, his father's family having followed the trade of tanner for some generations, and his mother's that of gardener. His father was a noncommissioned officer in Napoleon's army, a man of much force of character but hardly giving promise of being the father of one of the world's greatest scientists. The father was 31 and the mother probably under 30, when Louis was born. For his paternal grandfather the figure is 22 and for the latter's wife, something less than 20, since she died at that age. The ages of the paternal grandfather's parents were apparently 36 and 30.

Incomplete as it is, it would be hard to find a pedigree offering more objections to Mr. Redfield's hypothesis than does that of Pasteur.

MICHAEL FARADAY

Faraday (born 1791) is one of the few men of science worthy to be ranked with Pasteur. His ancestry is equally remarkable in showing no trace of scholarship prior to the appearance of the one prodigy. His father was a blacksmith, his mother an uneducated farmer's daughter. The age of the former was 30, and of the latter 27

[9] Turquan, V. De la durée de la génération en France. *Jour. de la Soc. de Stat. de Paris* 37 (1896). The other French studies are quoted from Turquan.

[10] The *Life of Pasteur*, by his son-in-law, René Vallery Radot, should be read by every student of biology.

The only other age known is that of the paternal grandfather, 33. Here again, so far as the recorded facts allow one to judge, Mr. Redfield's hypothesis does not appear to fit.

NAPOLEON BONAPARTE

Thanks to the assiduity of hero-worshippers, the genealogy of the first Napoleon has been well established,[11] at least up to the time when the family moved from Italy to Corsica. Not enough of the dates are known to bring it within the scope of Mr. Redfield's offer; but enough of the dates are known to furnish very strong evidence against Mr. Redfield's hypothesis. At the time of Napoleon's birth in 1769, his father was 23 and his mother 19. The maternal grandparents were probably both 27, and the maternal great-grandfather 26. Going back in the tail-male from Napoleon's own father, the ages are 33, 30, 30, 20, 26 and 34, the latter being that of Sebastiano Bonaparte, who was born in 1603 and married Maria Rustelli in 1630. While these figures cover only a part of the ancestry, the dates of marriage of some of the other persons in the pedigree give reason to suppose that they represent the general average. Whether or not one whole-heartedly admires Napoleon, one cannot deny his tremendous talents; and these talents cannot be explained by Mr. Redfield's hypothesis. They fit in well with the accepted views of heredity, however, for the Bonaparte family was one of noble origin, and in every generation had shown ability.

Turquan found the average generation in the male line, in Corsica, to be 35 years, in the female line 31. It is thus evident that, in modern times at any rate, the island is not conspicuous for early marriages, a fact which makes the ancestry of Napoleon all the more striking.

SOME OTHER CASES

Five generations in the tail-male of Julius Caesar's ancestry apparently represent an average of 29 years each. The only date known in the ancestry of H. Helmholtz, who had as great an intellect as was ever made in Germany, is that of the father, who was 29 when his son was born. Leonardo da Vinci, born in 1452, was the son of a 25 year-old law student and a peasant girl. Five generations of ascent in the male line of Charlemagne's pedigree show an average of 33 years. Christopher Columbus' father was 25 at the time the explorer was born. But perhaps no case is more surprising than that of John Napier, inventor of logarithms and a man of immense mental capacity, whose father was 17 and grandfather 24.

Pedigrees such as have been cited above are at least enough to make one feel that Mr. Redfield's hypothesis has many difficulties to overcome before acceptance. But none of the pedigrees mentioned was submitted in such form as to meet the requirements laid down by Mr. Redfield in sections 1 and 2 of his offer.

Of course, the cases just enumerated are selected cases. It is not intended here to deny that great men are most likely to come from families where marriage has been later than the average. These selected cases are presented to show that Mr. Redfield's claim that great men cannot come from any other kind of family rests on an insecure basis. He has never attempted to justify his hypothesis by the only method which would test it—namely, by an investigation of the order of birth of sons in the same family, to ascertain whether the later-born more frequently attain greatness than do the earlier-born.

The production of great men from late marriages is quite what would be expected, on any hypothesis of heredity. Great men usually come from families which have more than ordinary intellect, and in such families, marriage is regularly postponed beyond the average of the race, because of economic and social reasons.

The question of educational influences likewise needs, among others, to be

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[11] See *Le Nid de l'Aigle* by Colonna de Cesare Rocca; and *Memoires sur l'enfance et la jeunesse de Napoleon*, par l'abbé T. Nasica (Paris, 1852). The author was juge d'instruccion in Ajaccio 1821–9, where he collected the material for his work.

taken into account. The more aged parent has accumulated more experience, which he can pass on to his children by word of mouth and by example (not, as Mr. Redfield supposes, through his germ-plasm). It may be that the later-born children in a family benefit in a similar way, the father having more often reached an age where he can retire from most active work and spend more time on the training of his children; and farther, they have a distinct advantage in being stimulated to rival their elder brothers and sisters.

These and similar considerations may account in large part for the general fact that great men are the product of late marriages. Whether or not they are wholly sufficient, it is highly unscientific to ignore them utterly as Mr. Redfield does.

Apart from these educational differences, it is not impossible that order of birth is associated with differences of some sort in mental inheritance, as it is with physical inheritance. It is known that the later-born members of a family are more variable in height and weight. It is also known that the earlier born members of a family are longer-lived than are the later-born. On the whole, the younger parents seem to bear the physically better children; it is difficult to believe that there is an antithesis between mental and physical traits, as would exist if Mr. Redfield could prove his hypothesis. The whole problem needs careful study from this aspect.

THE EVIDENCE FROM LIVE-STOCK BREEDING

Mr. Redfield has made use of pedigrees of trotting horses, milk cows and dogs to support his views, and was anxious to secure, through the American Genetic Association, additional evidence from the field of live-stock breeding. The only material submitted under this head is from Lucille H. Cruickshank and G. N. Neagle of the University of Kentucky, who call attention to the brown mare Fereno (born 1897), winner of the Kentucky Futurity as a two-year-old (2:17) and again in the following year (2:10¾). Later she reduced her record to 2:05½. This record places her among a select few of the standard breed.

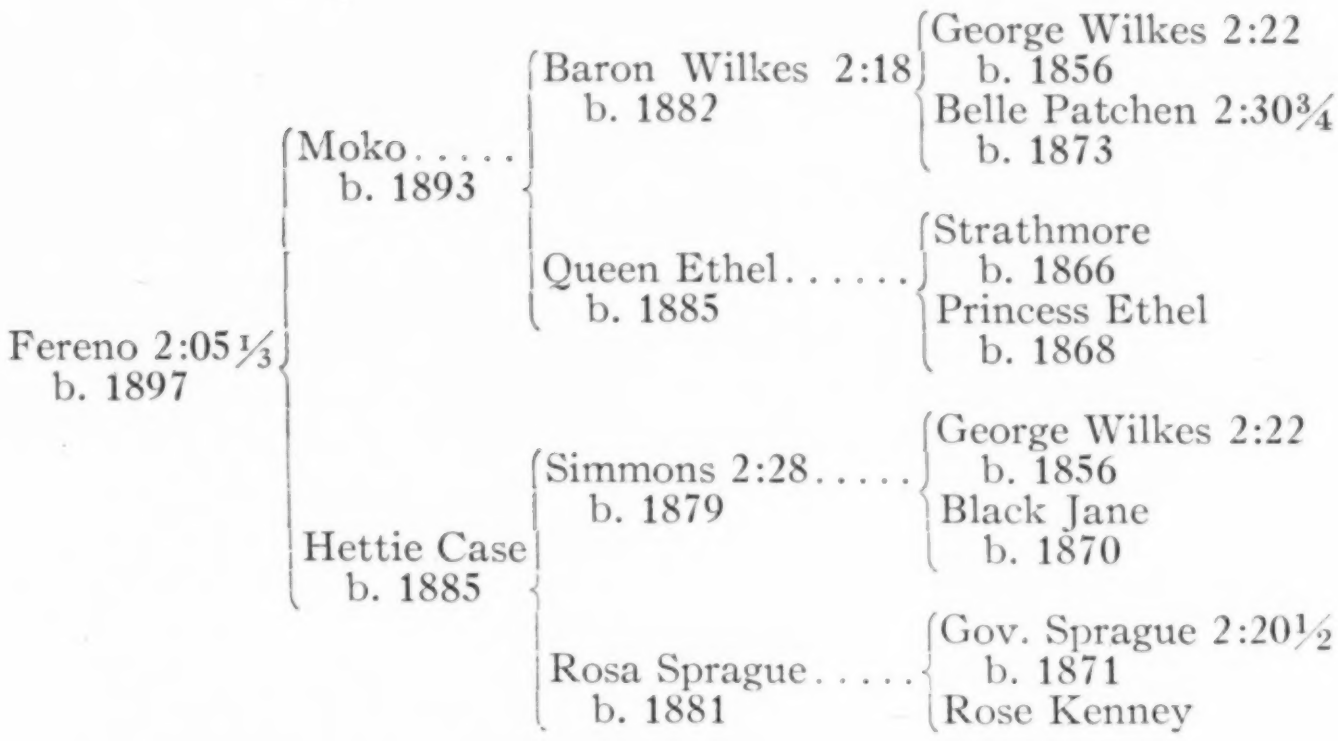
Her sire is Moko, who has no record, and who was only 3 years of age when he sired her. His training prior to this time is negligible, as he went lame and was sent to the stud instead of the track. Moko's dam and her line of dams were mares of no consequence, so far as performance is concerned, and there is no record of their doing anything on the track. Their value as brood mares is in their possession of the blood of Stockbridge Chief and Hambletonian 10.

Hettie Case, the dam of Fereno, was a good-looking mare, but has no record, and is said never to have been trained. The custom in Kentucky is to allow the brood mares and fillies intended for brood mares to run in the pastures, and they do not get any other exercise than eating blue-grass. After her famous daughter, Fereno, became known, Hettie Case had every opportunity to produce trotting colts to good sires, but her other produce were failures.

The dam of Hettie Case was Rosa Sprague, who was only 4 years old when Hettie Case was foaled. She has no record, and in fact was not a trotting-bred mare at all except on her sire's side, and is recorded as nonstandard. She is said to have had no training.

Moko is living, is noted as a sire of futurity winners, and has a most wonderful record as a sire of fast trotting horses, standing perhaps only second to any living or dead sire of the breed; yet he has not since his three-year-old form, despite all his opportunities in the stud to secure the very best bred mares of the United States, been able to produce a foal that has had the ability to lower the record of Fereno.[12]

[12] This is no longer true. Last year The Real Lady, a daughter of Moko, made a record of 2:04¼. See Wallace's *Yearbook*, Vol. xxxii, p. 623. Up to the time that volume of the yearbook was compiled, Moko was the sire of 132 recorded trotters and 11 pacers.



THE REMARKABLE PEDIGREE OF FERENO

Fereno is a very fast trotter. According to Mr. Redfield's hypothesis, her pedigree should show animals which were worked hard and bred at a late age. The facts shown in the chart above are evidence that a number of her ancestors had no records at all; and if the intervals between generations are counted, it will be found that most of the ancestors of Fereno were bred young. The date of birth of Rose Kenney is not known, but her grandsire, Mambrino Chief, was foaled in 1844. Thus three generations, from the birth of Mambrino Chief to the birth of Rosa Sprague, cover 37 years, and one-third of this is 12.3 years. It will therefore probably not be far wrong to take 12 years as the age of Rose Kenny at the time Rosa Sprague was foaled. (Fig. 9.)

The dam of Fereno had every chance, mated to great sires, to produce something better than Fereno, but instead has produced nothing of great value since then.

The pedigree of Fereno is shown in Fig. 9. Her sire and dam are without records, and only two of her grandparents have records. In earlier generations she has many good ancestors.

The average age of all Fereno's ancestors, compared with the average age of *male* ancestors only of 242 trotters with records of 2:10 or better and of a random group of the first 242 horses in Volume 15 of the Register[13] is as follows:

	Sires	*Grandsires*	*Great grandsires*	*Great great grandsires*
Fereno	7	6.25	14.75	11.27
Average horses	8.28	10.65	11.64	12.78
2:10 horses	9.4	11.5	12.5	13.5

The fact that Fereno's ancestors of both sexes are included in the above table brings an element of uncertainty into the comparison; but on the whole it appears very unfavorable to Mr. Redfield. And the fact that Fereno, a distinctly superior trotter, was produced by an untrained three-year-old stallion, and a brood mare who never before or since produced a superior colt, and who had no record, is very damaging to Mr. Redfield's claims, and seems to justify the contributors in pointing to Fereno "as a clear-cut example to comply with offer No. 3, where the parents made acquirements below the standard, in respect to performance, and the offspring surpasses the parents." However, Mr. Redfield stipulated that the evidence must show the actual amount of training given to the two parents, and as this information cannot be secured, it is impossible to award his money.

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[13] Marshall, F. R. The Age of Speed Sires. *American Naturalist*, Vol. xliv, p. 433, July, 1910. The article is a criticism of some of Mr. Redfield's figures.

THE FOUNDATIONS OF MR. REDFIELD'S HYPOTHESIS

This is not the place for a critical examination of Mr. Redfield's hypothesis in detail.[14] But the publicity which the JOURNAL OF HEREDITY has given to his offers might lead someone to suppose that the JOURNAL sympathized with his conclusions; and this would be unfortunate. It is therefore desirable to point out what appears to be the fundamental weakness of his hypothesis. The data which he has accumulated are of value, even though his own interpretation of them cannot be accepted; and it was with the hope of accumulating more data that the JOURNAL OF HEREDITY coöperated with Mr. Redfield.

The Redfield hypothesis, that the parent passes on to his children the effect of his own experience, training or education, may for the sake of convenience be considered here solely in its application to man. It is untenable (1) because it ignores much that has been learned about the mind, and (2) because it ignores more that has been learned about the body.

1. In the light of modern psychology, it is absurd to lump all sorts of mental ability under one head, and to suppose that the father's exercise of reasoning power, for example, will store up energy to be manifested in the offspring in the shape of executive or artistic ability. Mental abilities are much subdivided, and are inherited separately. Mr. Redfield's idea of the process is much too crude.

Moreover, Mr. Redfield's whole conception of the increase of intelligence with increase of age in a parent, shows a disregard of the facts of psychology. As E. A. Doll has pointed out,[15] in criticising Mr. Redfield's recent and extreme claim that feeblemindedness is the product of early marriage, it is incorrect to speak of 20, 30, or 40 year standards of intelligence; for recent researches in measurement of mental development indicate that the heritable standard of intelligence of adults does not increase beyond the age of approximately 16 years. A person 40 years of age has an additional *experience* of a quarter of a century, and so has a larger mental content, but his intelligence is still at the sixteen-year level. Mental activity is the effect, not the cause of mental growth or development. Education merely turns innate mental powers to good account; it makes very little change in those powers themselves. To suppose that a father can, by study, raise his innate level of intelligence and transmit it at the new level to his son, is a naïve idea which finds no warrant in the known facts of mental development.

2. In his entire conception of the storing-up and transmission of energy, Mr. Redfield has fallen victim to a confusion of ideas due to the use of the same word to mean two different things. He thinks of energy as an engineer; he declares the body-cell is a storage battery; he believes that the athlete by performing work stores up energy in his body (in some mystic and undescribed manner) just as a clock stores up energy when it is wound. The incorrectness of supposing that the so-called energy of a man is of similar nature, is remarkable. If, hearing Bismarck called a man of iron, one should analyze his remains to find how much more iron he contained than ordinary men, it would be a performance exactly comparable to Mr. Redfield's, when he thinks of a man's "energy" as something stored up by the performance of work.

As a fact, a man contains less energy, after the performance of work, than he did at the start.[16] All of his "energy"

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[14] See Raymond Pearl's review of Mr. Redfield's *Dynamic Evolution* (JOURNAL OF HEREDITY Vol. vi, p. 254): "Like all pseudo-science, Mr. Redfield's is a conglomerate mixture of the true, the false, and the unknown."

[15] Doll, E. A. Education and Inheritance. *Journal of Education*, 85–5, Boston, February 1, 1917.

[16] Atwater's celebrated experiments proved that all the energy (food) which goes into an animal can be accounted for in the output of heat or work. They are conveniently summarized in Abderhalden's *Text-book of Physiological Chemistry*, p. 335.

comes from the metabolism of food that he has previously eaten. His potential energy is the food stored up in his body, particularly the glycogen in the liver and muscles.

Why, then, can one man run faster than another? Mr. Redfield thinks it is because the sprinter has, by previous work, stored up energy in his body, which carries him over the course more rapidly than the sluggard who has not been submitted to systematic training. Such a view is preposterous. The differences in men's ability are not due to the amount of energy they have stored up, but to differences in their structure (using this word in a very broad sense) which produce differences in the efficiency with which they can use the stored-up energy (*i. e.*, food) in their bodies. A fat Shorthorn bull contains much more stored-up energy than does a race-horse, but the latter has the better structure—coördination of muscles with nervous system, in particular—and there is never any doubt about how a race between the two will end. The differences between the results achieved by a highly educated thinker and a low-grade moron are similarly differences in structural efficiency; the moron may eat much more, and thereby have more potential energy, than the scholar, but the machine, the brain, cannot utilize it.

The effects of training are not to store up energy in the body, for it has been proved that work decreases rather than increases the amount of energy in the body. How is it, then, that training increases a man's efficiency? It is obviously by improving his "structure," and probably the most important part of this improvement is in bringing about better relations between the muscles and the nerves. To pursue the analogy which Mr. Redfield so often misuses, the effects of training on the human machine are merely to oil the bearings and straighten out bent parts, to make it a more efficient transformer of the energy that is supplied to it.

The foundation stone of Mr. Redfield's hypothesis is his idea that the animal by working stores up energy. This idea is the exact reverse of the truth. While the facts which Mr. Redfield has gathered deserve much study, his idea of "Dynamic Evolution" need not be taken seriously.

Plant-breeding in Russia

The advancement of genetics in Russia is principally dependent on the Bureau of Applied Botany of the Ministry of Agriculture, which was founded in 1894 and completely reorganized in 1907 on the lines of the American Bureau of Plant Industry. Since 1904 it has been directed by Robert Regel. The bureau's monthly *Bulletin of Applied Botany*, which is published in Russian with abstracts of important articles in English or French, gives (December, 1916) a summary of the work accomplished by the bureau to date, which shows a great deal of fundamental investigation in plant-breeding, as well as attention to the practical problems which are always pressing. It may be added that fifteen of the Russian government's plant-breeders are members of the American Genetic Association.

One of the important accomplishments of the bureau is the translation and publication in Russian of plant-breeding literature. In this way most of the five volumes of Fruwirth's monumental work on plant-breeding have been made available for Russian workers, with many other treatises on special subjects. Mendel's writings and some of those of Baur, Shull and other geneticists have also been translated.

The greatest genetic work of the bureau has naturally been to study the varieties of cultivated plants of Russia, isolating the best pure lines from these for dissemination. The extensive account of this which the *Bulletin* publishes indicates that the work has been of immense value to Russia, and may be of great value to other countries with similar climates.

MUSCADINE GRAPE BREEDING

The Native Grape of the Southeastern United States Has Been Hybridized Successfully with the European Grape—Valuable Self-fertile Varieties Produced.—A New Possibility for the Cut-over Pine Lands of the South

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IT IS a well-recognized fact that cultivated grape varieties derived from the species native to a particular locality thrive under the environmental conditions existing there. The grape varieties best adapted to the hot and more or less arid portions and the higher elevations of the South Central States are those produced by T. V. Munson of Texas, Herman Jaeger of Missouri, and others, from the summer grape, *V. aestivalis*, of the southern Great Plains area. The best grape varieties for the northeastern United States are those, such as Concord, which have been obtained from the northeastern fox grape, *V. labrusca*. The varieties of the river-bank grape, *V. riparia*, thrive in alluvial districts. In like manner the Muscadine[1] grapes, *V. rotundifolia* and *V. munsoniana*, are the proper species for the Southeast because that is their native home. For this reason, in endeavoring to foster grape culture in the Coastal Plain, Piedmont, and Gulf sections of the southeastern United States, the U. S. Department of Agriculture has endeavored to ameliorate the native Muscadine grape rather than to introduce varieties of species known to be ill adapted to the climatic and other environmental conditions.

In their native habitat the Muscadines thrive and produce abundant crops. They do well on lands where other fruits do not succeed, flourishing in poorly drained soils, and warm, humid atmospheric conditions which are detrimental to other species of grape. They have been cultivated for a great many years in the Southeast, but little effort was made until recently to bring about improvement through breeding. Even at the present time the standard commercial varieties are less than six in number and all named varieties are of the *V. rotundifolia* species. These varieties have been named, propagated and disseminated merely because they represented the best that occurred in Nature. Even so, however, they are good grapes, highly prized by the people of the South, who grow them extensively for wine, table, and culinary purposes.

In addition to being native to the Southeast and adapted to soil and climatic conditions there, the Muscadines further qualify as the best grapes for that section by having such desirable characteristics as:

1. Vigorous growth habit.
2. High productiveness.
3. Distinctive and agreeable flavor.
4. Large berries.
5. Late and long blooming period, insuring regular crops.
6. Resistance to diseases and insects.
7. Marked ability to withstand adverse conditions, though responsive to good care.

[1] The Muscadine grapes, which include two botanical species, *Vitis rotundifolia* and *Vitis munsoniana*, are one group of the grape genus. This group is called *Muscadinia*. The other group, comprising the other native grape species and the European grape (*Vitis vinifera*), is called *Euvitis*. The *Muscadinia* is distinct from *Euvitis* botanically in that it has closely adherent bark on the branches, continuous pith through the nodes, unforked tendrils, and flattened seeds with transverse wrinkles on both sides.

A VINEYARD OF MUSCADINE GRAPES

The ground crop is crimson clover. Sometimes sheep are pastured on it, which makes three-story agriculture. The Muscadine grape is a favorite in the southeastern United States where it is native, but offers much room for improvement. Unlike the ordinary grape the Muscadine has been trained high on overhead trellises. (Fig. 10.)

8. Ability to produce profitable crops for 100 or more years.

With such creditable characters, though still a practically untamed branch of the grape family, the Muscadines seemed to offer unusual opportunity for improvement. On the other hand, there were certain difficulties in the way of improvement which the Department recognized from the beginning. For instance, there was not a single known self-fertile variety among the Muscadines, thus necessitating the use of a wild male vine of unknown fruit character in every cross. The only available female varieties were those which had been brought under cultivation and more or less disseminated by persons finding them in the woods and recognizing them as superior to the average wild grape. Nothing was known about the parentage of these varieties and as their distribution had been more or less limited to the vicinity in which they originated their real varietal value had not been established. There were no improved male vines and their need had not been realized, as the importance of providing cross-pollination facilities was unknown.

Such were the conditions when the U. S. Department of Agriculture undertook to improve the Muscadine grape in those ways in which improvement seemed desirable and possible. Apparently these were:

1. Production of improved male vines.
2. Production of self-fertile varieties.
3. Greater productiveness.
4. Increased size of fruit cluster.

TYPES OF MUSCADINE GRAPE BLOOM-CLUSTERS

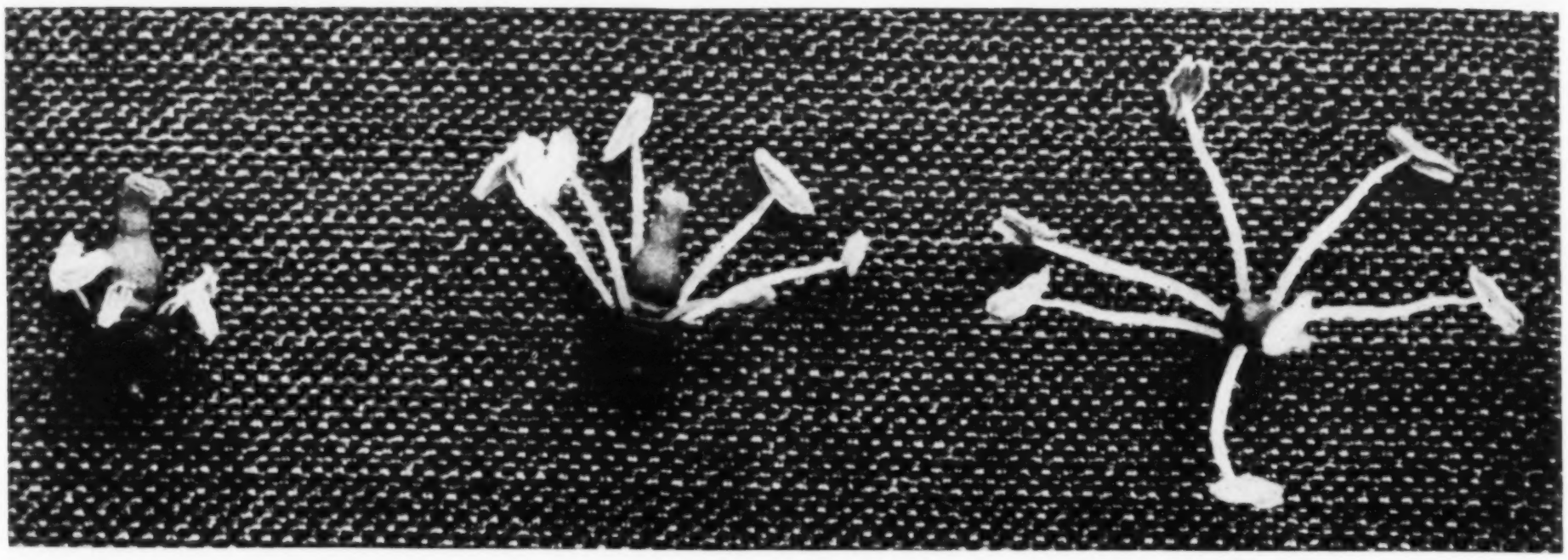
The small cluster on right is typical of the female or, more properly, imperfect hermaphrodite type. All the standard commercial varieties are of this type and the cluster photographed is of the leading variety, Scuppernong. The cluster on left is a typical male or staminate vine cluster. The middle cluster is typical of the new perfect-flowered, self-fertile hermaphrodite type produced by the U. S. Department of Agriculture. Note that it resembles the male cluster in size and shape rather than the female cluster, and that it has erect stamens surrounding a normal pistil in each blossom while the male cluster has no pistils and the female cluster has only short, rudimentary stamens. Photograph one and one-half times natural size. (Fig. 11.)

5. Better berry adherence.
6. Higher sugar and lower acid content.
7. Better pulp quality.
8. Decreased size of seed.
9. Thinner skin of berries.
10. More uniform ripening.

The early surveys showed that the main problem of breeding would be to bring together the desirable characters already present in the two species constituting the Muscadine group, especially *V. rotundifolia*, though it also seemed necessary to go outside of the group for certain other improvements, such as marked alteration of the sugar-acid ratio. The efforts of the Department, therefore, have been, first, to combine and augment in a few varieties the desirable characters now scattered among many varieties of the Muscadines, by cross-breeding and selection work within the species; and, second, to bring about additional improvement by hybridizing with other grape species.

RESULTS FROM INTERCROSSING

In practically every way in which improvement seemed desirable as already indicated, improvement has been secured. Among the more than 5,400 seedling vines produced by the Department there are selected individuals which represent progress toward certain ones of our stated goals and the best of these are being multiplied and thoroughly tested with a view to introducing them eventually as named varieties



TYPES OF MUSCADINE GRAPE BLOSSOMS

At the left is the imperfect hermaphrodite blossom—the so-called female. The male or staminate blossom is at the right, while the new, perfect type produced by the U. S. Department of Agriculture is shown in the center. It will be noted that this new type is a self-fertile hermaphrodite, which produces pollen for its own flowers. Its introduction will do away with the necessity of giving space in a vineyard to male "drone" vines that yield pollen but no fruit. The flowers are photographed about three times natural size on a background of very fine silk. (Fig. 12.)

recommended for planting. Many of these varieties are improved in more than one character.

Intercrossing has been extensively practiced from year to year, the best available fruiting vines being pollinated by the best male seedlings of desirable groups. This work has necessitated most intimate and careful study of the thousands of seedlings produced, in order to be able to select parents intelligently. Certain male vines have become known by their behavior in cross-breeding just as the fruiting seedlings are known by the fruit characters they possess and transmit.

1. Production of Improved Male Vines

One of the first results, therefore, from cross-breeding operations has been the obtaining of certain male vines, selected seedlings, which are improved varieties to the extent that they transmit desirable rather than undesirable characters and because they have been selected for vigor, freedom from disease and insect attacks, profuseness of bloom, long period of bloom, and proper time for bloom (*i. e.*, simultaneous with fruiting varieties to be pollinated). These better male vines have, where conditions warranted, already been distributed to grape growers along with fruiting vines to be tested coöperatively in representative sections of the Muscadine territory.

2. Production of Self-fertile Varieties

Undoubtedly the most important result of the department's work is the production of self-fertile varieties. It should be emphasized that at the time these investigations were undertaken, there was not such a thing as a self-fertile Muscadine grape. All the fruiting varieties were self-sterile and dependent on insects to bring fertile pollen from the wild male muscadines. The Department now has a large collection of self-fertile varieties.

The value of these self-fertile varieties is evident. (*a*) They are of inestimably great value in breeding work in that they afford for the first time the opportunity to intercross within the species without using as one parent a variety of unknown fruiting qualities (male vine). We can now breed directly for a combination of the desirable characters found in the fruiting varieties of *V. rotundifolia*. (*b*) They afford directly a cluster of increased size (a breeding object) in that the self-fertile varieties are the result of perfecting the large-clustered male type blossoms rather than the small-clustered female type blossoms. (*c*) They afford greater productiveness in that they are able to set

BLOOM-CLUSTERS OF TWO HERMAPHRODITE MUSCADINE GRAPES

At the left is a cluster from the one of the original hermaphrodites, known as H2, and on the right a cluster from H1, the other original hermaphrodite. The good size and proportions of the latter cluster are particularly noteworthy. Photograph about natural size. (Fig. 13.)

as berries from 25 to 50 per cent of the bloom buds, whereas the standard but self-sterile variety Scuppernong, for example, has set at Willard, N. C., under the best natural conditions less than 12% of the bloom buds annually for the last six years, owing to the fact that it must rely on insect cross-pollination. (*d*) The new self-fertile varieties afford opportunity for greater vineyard production as well as vine production, for they can be planted in place of nonproductive male vines as pollinators for female varieties (morphologically imperfect hermaphrodites).

The production of a self-fertile Muscadine grape means the production of a new type of Muscadine grape; one having a new type of bloom which is at once male and female and designated as *perfect* or *hermaphroditic*. This is so important to the industry that a rather full statement seems warranted here in order to show just what has been done.

The Department began its breeding work in 1907. The crosses that year

were made chiefly in a commercial vineyard at New Smyrna, Fla., which contained the largest collection of varieties then in existence and was surrounded by quantities of native vines of *V. munsoniana* and *V. rotundifolia*, the two species constituting the *Muscadinia* group. In the same year, following the Florida work, other crosses were made at several places in Georgia, South Carolina, and North Carolina, where desirable material had been located. The seedlings resulting from this work were propagated in Washington and planted in the experiment vineyard at Willard, N. C., as the first seedling vineyard. Later when these seedling vines began to fruit and bloom, two of them were found to be true hermaphrodites, perfect-flowered, and self-fertile, whereas the other seedlings and all other Muscadine grapes were either staminate or pistillate.[2] The two original true hermaphrodites will be designated as H1 and H2 in the following discussion. H1 was the result of a cross at New Smyrna, Fla., between the standard female variety Eden and a wild, dark type, male, *V. munsoniana* vine. H2 was the result of a cross at Medoc Vineyard, Enfield, N. C., between the standard female variety Scuppernong and a light type male vine.[3] A large number of the seedlings were of the same parentage as the two hermaphrodites but male or female, like other Muscadines. From the two original hermaphrodites other hermaphrodites have been produced, but the Department has failed as yet to produce a third hermaphrodite of distinct parentage.[4]

Of the two original hermaphrodite seedlings, H1 is *V. munsoniana* in type, while H2 is entirely *V. rotundifolia*. The former has small black berries in relatively large clusters while the latter has large light colored berries resembling Scuppernong fruit, though not equal to Scuppernong in quality. The self-fertility of the latter is more pronounced.

Having produced the two original hermaphrodites, the next step was to multiply the type and to transmit the hermaphroditic character to other seedlings. H1 produced a little bloom in 1911. In addition to using this to test the seedling itself (*i. e.*, its pollen, pistils, and fruit), sufficient bloom was secured to pollinate two clusters of Eden, its female parent. This cross yielded two fruit clusters, one of eight berries and one of twenty-two berries, from which 154 seeds were secured. From these, fifty-four seedlings are now living and fruiting. Thirty of these (over 55%) are hermaphrodites and the rest females. Apparently the seedlings which in a normal Muscadine cross would be males are in this case hermaphrodites, or, figuratively, pistils have been inserted in the staminate blossoms making true hermaphrodite blossoms. These seedlings are as a group intermediate between their parents. The best are very prolific, large-clustered, with average-size black berries of good vinous flavor and good quality. They are closely similar and fully equal to Eden and in addition have the hermaphrodite character. The better representatives are being used as parents in the breeding investigations.

After being used in 1911, H1 was

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[2] The flower type designated as pistillate or female is morphologically really an imperfect hermaphrodite having rudimentary stamens. There is no true pistillate type of bloom among the Muscadine grapes. The imperfect hermaphrodite bloom, however, behaves as a pistillate rather than as a hermaphrodite.

[3] Male and fruiting vines of the Muscadines are of two types, light and dark, and this color character of the vine is correlated with the color of the fruit. Vines having reddish veins, young tendrils, and growing tips produce dark fruit (pink, red, purple, or black), while vines with light yellowish-green growing tips produce light fruit (yellow, bronze, pearly, or green). The males are classed likewise as indicated by their progeny.

[4] Since this paper was written the third hermaphrodite of distinct parentage has been produced. As it began blooming only recently and has not yet fruited, further reference to it is omitted. It is a vigorous vine of the light type and has set fruit readily under bags. Its pollen germinates vigorously in sugar solution. It has been successfully used to pollinate standard varieties and other hermaphrodites and it has been successfully pollinated with pollen from male and from other hermaphrodite vines. It is the result of a cross in 1913 between two seedling vines in the Muscadine Grape Experiment Vineyard at Willard, N. C.

FLOWERS, GREEN CLUSTERS AND RIPE GRAPES

Clusters picked on October 2 from one of the original true hermaphrodite vines, H1. They show the berry characters, and also show that fruit of all sizes is to be found at one time, from the ripe berry to the blossom. This extends the season of the fruit advantageously. Four-fifths natural size. (Fig. 14.)

killed to the ground during the severe winter of 1911-12, but sprouted and has not since shown injury. Vines propagated by cuttings from it are now fruiting in the varietal collection.

In 1912 sufficient pollen of H2 was available to permit limited crossing, from which one Scuppernong cross, seven James crosses, and five selfed crosses are now fruiting. The seedling of Scuppernong parentage is a female, but subsequent crosses have shown that this was merely chance. Had there been more seedlings produced, some would undoubtedly have been hermaphrodites. Of the seven James crosses, three are hermaphrodites and four females. One of the hermaphrodites is the dark type and very similar to James in fruit quality, while the other six seedlings are of the light type, bearing light fruit. The two light hermaphrodites are much like James in habit, but light-fruited. We thus have not only a hermaphroditic equivalent for James in the dark seedling, but a new type which can be described as a hermaphroditic, light-fruited combination of James and Scuppernong. Of the five self-pollinated seedlings of H2, all are of the light type, all hermaphrodites, all markedly self-fertile, and all very similar to the parent.

In 1913 sufficient bloom was produced on H2 to pollinate the leading varieties and some of our best female seedlings. The object of this work was to produce hermaphrodites so nearly resembling the present leading varieties in fruit qualities as to permit substitution, and also to produce hermaphroditic combinations between the standard variety types. During the season of 1916 the seedlings resulting from this 1913 work began fruiting, and the results, while not all that might be desired, are very encouraging. In addition to some new fruit-type seedlings having the hermaphroditic bloom character, we apparently have now what might be characterized

as James, Scuppernong, Thomas, Eden, and Flowers hermaphrodites. However, as these seedlings are only beginning to fruit, this statement is subject to modification. A full test may show the necessity of working into or toward the different standard varietal types through another generation before practically identical hermaphrodites may be available as substitutes for the present standard female sorts. The following table shows the hermaphroditic results (tabulated June 30, 1916) from crosses in which H2 figured in 1912 and 1913 breeding work.

will be hermaphrodites. These seedlings are chiefly of the third generation, being progeny of hermaphrodite seedlings of H1 and H2 parentage. So far, while it has been possible to self-pollinate H1 and H2, it has been impossible to cross them directly.

3. *Increase of Productiveness*

Increased productiveness is a leading result secured by the Department in its intercrossing work. This has been accomplished in three different ways.

First, it has been possible to gradually increase the standard of productiveness by selecting among the thousands of seedlings those which give evidence of

In 1914 a considerable number of

TABLE 1.—*Hermaphroditic Results from H2 in* 1912 *and* 1913 *Breeding Work, Willard, N. C.*

Year	Parentage (pollen parent stated last)	Total number seedlings	Number hermaphrodites	Number female	Number male	Number not yet tested
1912	H2 ☿ —bagged (*i. e.*, self pollinated)	5	5			
	James ♀ x H2 ☿	7	3	4		
	Scuppernong ♀ x H2 ☿	1		1		
1913	Scuppernong ♀ x H2 ☿	13	4	3		6
	James ♀ x H2 ☿	16	7	7		2
	Thomas ♀ x H2 ☿	15	4	5	1	5
	Flowers ♀ x H2 ☿	13	5	4		4
	Eden ♀ x H2 ☿	27	14	4	1	8
	V16 R6 B2 ♀ x H2 ☿	23	14	7		2
	V47 R9 B2 ♀ x H2 ☿	2	1			1
	V80 R3 B2 ♀ x H2 ☿	2	1	1		
	V21 R15 B2 ♀ x H2 ☿	1				1
	H2 ☿ x V28 R2 B2 ♂	8	1		2	5
	Total	133	59	36	4	34

crosses were made using H2, H1, and the better hermaphroditic progeny of H1. Additional work was done in 1915, but the resulting progeny have not yet bloomed. To date,[5] in addition to the two original true hermaphrodites and plants propagated from them by cuttings, the Department has produced ninety tested hermaphrodites, fifty-nine tested females, and five tested males from crosses in which H1 and H2 have figured. In addition, there are 1,029 seedlings of hermaphroditic parentage in the breeding blocks of the experiment vineyard still untested. It is expected that not less than 50 per cent of these highest productiveness due to profuse-

ness of bloom, vigor of growth, resistance to diseases and insects, etc., and then using these as parents of succeeding generations. To make this increase effective merely requires the introduction and substitution of the better new varieties for the present standard commercial sorts.

Second, increased productiveness has been gained by producing the new self-fertile hermaphroditic type of Muscadine grape having large clusters, self-fertility, and fruitfulness, to take the place of female varieties and of nonfruiting male vines serving as pollenizers for female varieties. Owing to the self-fertility of the hermaphrodites they

[5]This manuscript was prepared in November, 1916.

STANDARD AND IMPROVED GRAPE CLUSTERS

The small bloom cluster in the lower left-hand corner is typical of Scuppernong, the most widely grown variety of Muscadine grape. It bears only a few berries. The large cluster is typical of one of the improved hermaphrodites which the U. S. Department of Agriculture has produced as the result of many years of careful plant-breeding. It excels not only in size, but in almost every other characteristic. Photograph about one and one-half times natural size. (Fig. 15.)

have been found by test to set in bags over 33% of the bloom buds as berries, while Scuppernong, the most extensively planted commercial variety, sets naturally less than 10% of its buds as berries.

Third, by breeding for increased size of bloom cluster it has been possible not only to secure larger fruit clusters (a breeding object), but also increased productiveness. Large bloom clusters result in more perfect cross pollination and the size of bloom cluster is not necessarily in inverse ratio to profuseness of bloom cluster. The number of bloom clusters produced by a vine is ordinarily determined by its general vegetative condition, and little influenced by the size of the individual bloom cluster. Varieties with large bloom clusters secure better cross pollination and therefore are more fruitful. As the pollen-bearing insect is attracted to the flower by its odor,[6] a large bloom cluster has greater attracting power than a small one, and when the cluster is once found, all open blossoms are pollinated, whereas if this number of open blossoms is found on two clusters the insect might fail to visit one of them. Again, the large bloom cluster, in addition to having more buds open at a time, blooms over a period of two to three days and is therefore much more likely to have sufficient buds to produce a normal cluster open under favorable weather conditions. One illustration of the way these facts have been used in the Department's work seems warranted.

Among the fruiting varieties of Muscadine grapes Scuppernong is the oldest and the leading commercial sort. Its commercial value lies in its good light-colored fruit, and Scuppernong grapes have sold repeatedly to winemakers at good prices when dark-fruited varieties were not in demand. Still it can be emphatically stated that Scuppernong is one of the most unproductive varieties grown. An eight-year record (1904–1911) in a well-kept eastern North Carolina vineyard consisting of approximately 5 acres each of James and Scuppernong revealed that James yielded each year approximately twice as much fruit per acre as Scuppernong. Similar results have been repeatedly noted since. A prime reason for the relative lack of productiveness in Scuppernong has been shown by our pollination experiments to be its very small bloom cluster, which reduces the chances for cross-pollination by insects. The following data collected in connection with pollination studies will emphasize the bearing of size of bloom cluster on productiveness of Scuppernong and other commercial varieties. These data represent the averages of a very large number of individual observations during four seasons.

Variety	Average number of buds per bloom cluster	Average number of berries per ripe fruit cluster	Percentage of buds setting as berries under natural conditions
Scuppernong	23.8	2.5	4.64
James.....	28.0	4.7	13.36
Thomas....	30.3	5.4	16.32
Flowers.....	40.3	5.1	15.10

The correlation shown in this table between size of flower cluster and natural productiveness is most striking. Working on the hypotheses suggested by such data as these, the Department has produced by intercrossing and selection many large-clustered seedlings of the Scuppernong type. A number of these having bloom clusters of 35 to 50 buds, with apparently correlated productiveness, are now being further tested with a view to determining which combine the greatest productiveness with high fruit quality. Thus we have succeeded in improving the productiveness of this most important commercial type while maintaining its distinctive characters.

[6] Experiments show that it is the odor of pollen in rudimentary stamens of the female blossom that attracts the insects.

A PRODUCTIVE NEW VARIETY OF MUSCADINE GRAPE

Fruiting arm of one of the varieties of Scuppernong type produced by the U. S. Department of Agriculture. It gives an idea of the Department's method of pruning Muscadine grapes to spurred arms. It was formerly said that the vines would "bleed to death" if pruned, and failure to prune was responsible for many low yields, until the Department demonstrated that Muscadine grapes need pruning just as all other grapes do. (Fig. 16.)

4. *Increase in Size of Fruit Cluster*

The success of our efforts to increase the size of fruit cluster by intercrossing emphasizes how easy it sometimes is, in plant-breeding, to get combined improvement along several lines, provided these are not antagonistic. The efforts just described to increase productiveness by increasing the size of flower cluster necessarily resulted also in increasing the size of fruit cluster. Again, the transformation of the large male-type bloom into a perfect hermaphrodite bloom has resulted in increasing the size of fruit cluster. A third way in which intercrossing has resulted in increased size of fruit cluster is through the pollination of small-clustered varieties with pollen from the largest-clustered male seedling in groups of seedlings descended from the largest-clustered fruiting varieties.

While a considerable increase in size of fruit cluster has been obtained by intercrossing and selection among resulting seedlings, the greatest progress along this line is to be expected from hybridizing with the large-clustered species of *Euvitis*.

5. *Better Berry Adherence*

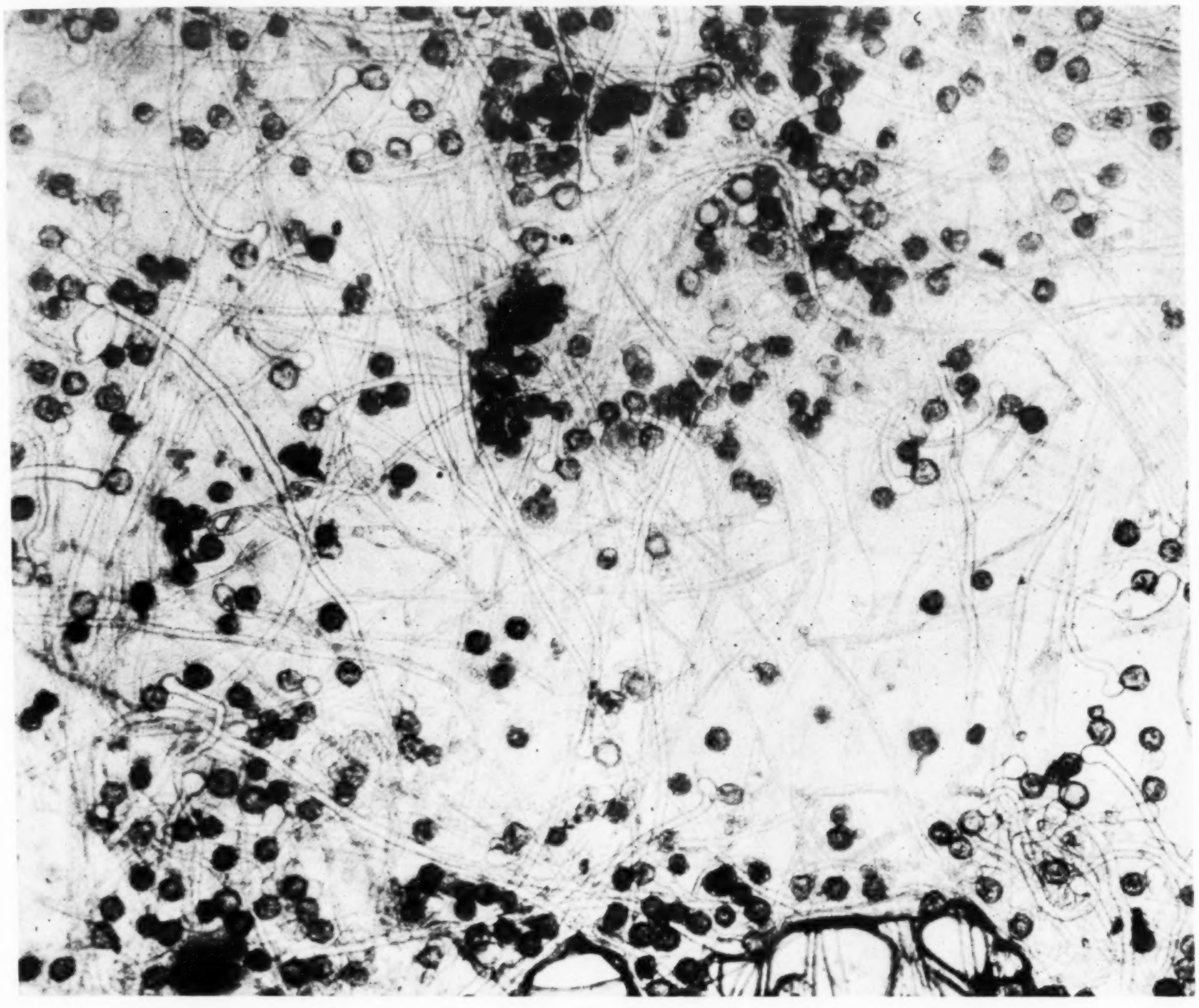
From a commercial standpoint, our improvement of the adherence of berry to pedicel by intercrossing is of great importance, since it makes possible the shipping of desirable varieties to distant markets. The standard Muscadine table varieties can not be successfully shipped, because the berries tend to shatter from the pedicels and in doing so the skin frequently breaks at the point of attachment, allowing juice to exude. This juice coats the berries, making them unattractive, sticky, and fermenty. Certain other varieties too coarse for table use and therefore undesirable for shipping, notably Flowers, have excellent berry adherence owing to full development of the fibrovascular bundles connecting the berry with the pedicel. By using male seedlings of Flowers and similar varieties in crosses with Scuppernong, Thomas, and other high-quality varieties of poor adherence, some desirable new types have been secured which combine quality and adherence.

6. *Increased Sugar and Decreased Acid Content*

The principal means used of reducing acid content has been to use parents and select offspring having a minimum of pulp juice and a maximum of so-called free-run juice, *i. e.*, the juice between skin and pulp of berry, as most of the acid content of the total juice of Muscadine and other native grapes occurs within the pulp. Sugar content is being increased by using such parents as Latham, Thomas, and Mish. A seedling of Latham parentage represents the greatest advancement in sugar content so far secured, but unfortunately has very small clusters. It is confidently believed that one or two more seedling generations will yield marked results in the effort to increase sweetness and reduce acidity. In this direction, however, greatest results are to be expected from hybridization with *V. vinifera*, the European grape.

7. *Improved Pulp Quality*

A number of seedlings of different parentages have been selected as having improved pulp qualities (smoothness, softness, and free liberation of seed.) In one lot of seedlings, however, the improvement has been especially marked. Among the first seedlings produced, one female seedling was selected as being exceptionally good because it combined with light-colored fruit and excellent berry adherence a remarkably melting pulp. In fact, there was no true pulp, the berries being merely globules of fruit juice. The juice, however, seemed a little too high in acid, and efforts have since been made to increase the sugar of this type while maintaining the desirable pulp and other qualities. A male seedling of the same cross as this exceptional one just described has invariably been found to impart the melting pulp character to its offspring. As a result we now have a considerable collection of melting-pulp seedlings of diverse parentage. These fruited for the first time in 1916 and will therefore require



VIGOROUS, GERMINATED POLLEN OF THE WINCHELL GRAPE

Each of the large dots in the above photomicrograph is a pollen grain. Most of them have germinated in a sugar-gelatin solution, and sent out long pollen tubes. Normally, this pollen tube grows into the ovary, after the pollen has fallen on a fruit-bearing flower, and down the tube the nucleus of the pollen-grain slips to unite with the nucleus of the ovule, thus setting in motion the machinery that will lead to the production of a grape-seed. The photograph, made at Willard, N. C., shows the condition of pollen as it was received by mail from Vineland, N. J. One of the chief factors in successful hybridization of the Muscadine grape has been the use of vigorous pollen. (Fig. 17.)

more testing before their full value can be determined. They are very promising.

8. *Decreased Size of Seed.*

Little reduction has been secured in the size of seed, but this character is considered of less importance than others, especially since the sizes of seed and berry are generally correlated.

9. *Thinner Skin of Berries*

Some reduction of the thickness of berry skin has been gained by intercrossing, especially with the variety Eden. A group of seedlings descended from Eden and James parentage is deserving of special mention here because of the uniform combination of good flavor and quality with thin skin, large berry and cluster, and good adherence. In this lot of seedlings some very promising light- and dark-fruited commercial types are to be found.

10. *Uniform Ripening*

Uniformity of fruit ripening seems to be dependent as much, on the weather at blooming time as on inherent varietal character. However, by working away from the everbearing trait of *V. munsoniana* and breeding

for large clusters, a little progress is to be expected. Most varieties ripen with sufficient uniformity if the weather is normal at blooming time.

RESULTS FROM HYBRIDIZING

So far the results from hybridization work are mainly in technique. The Muscadine grapes are so distinct and uncongenial to the other species of the grape family that hybridization is exceedingly difficult—so difficult, in fact, that the production of hybrids between *V. rotundifolia* and *Euvitis* species is considered an important result worthy of reporting, even though the hybrids have not yet fruited.

The difficulties to be encountered can be inferred from the experience of those who have given the matter most attention. J. Van Buren, of Clarksville, Ga., working prior to 1868, failed completely in the attempt. Dr. Peter Wylie, of Chester, S. C., working about the same time as Van Buren, produced several supposed Scuppernong hybrids which were lost to horticulture owing to a series of misfortunes, including the killing frost of April, 1872. T. V. Munson, of Denison, Tex., produced a few varieties which though predominantly Muscadine in character are supposed to be hybrids with *V. lincecumii*. Only four or five years ago a prominent State horticulturist made the statement that it was impossible to secure *V. rotundifolia* x *V. vinifera* hybrids. After two years' effort to produce hybrids of the *Muscadinia* and *Euvitis* species the North Carolina experiment station reported, in Technical Bulletin No. 10, complete failure with the exception of one weak plant, which was described when three years old as "still alive." A number of amateurs to whom we have sent pollen have all reported failure. The efforts of the U. S. Department of Agriculture were attended by failure until methods had been perfected and information regarding congeniality obtained. Since then, in addition to producing hybrids with various native grape species, the Department has produced the first known hybrids between *V. rotundifolia* and the European grapes, *V. vinifera*.

The Department's first efforts in this field, in 1911, resulted in complete failure. The next year one supposed hybrid was secured, a cross of Eden ♀ and Flame Tokay ♂, which has now fruited two years. While it is distinct from other Muscadine seedlings of Eden parentage, it is predominantly Muscadine in character and shows no resemblance to Flame Tokay except in the leaves. From the 1913 breeding work, twenty-two hybrids were secured, but only eight of these were living at the end of the first season in the vineyard. The others had succumbed to disease and inherent weakness. Of these eight seedlings, seven are of Olivette de Vendemain parentage and the result of one crossing operation. The other is the result of pollinating Scuppernong with Winchell. These seedlings have not yet fruited, but they should do so in the season of 1917. The Scuppernong ♀ x Winchell ♂ seedling is the only hybrid we have secured of Scuppernong parentage. It resembles Winchell more than Scuppernong, though from a Scuppernong seed. It is undoubtedly a true hybrid. The Olivette de Vendemain hybrids are variable in vigor and characters, some being vigorous and others weak; some are more Vinifera in type and others more Muscadine, but all are undoubtedly true hybrids. From the 1914 breeding work a considerable number of seeds was secured, but many of these failed to germinate. However, the following true hybrids were propagated and are now growing at Willard, N. C.:

2 seedlings of Eden x Maraville de Malaga
1 seedling, Thomas x Rodites
3 seedlings, Thomas x Carignane
1 seedling, Thomas x Noah
1 seedling, V16 R6 B2 x Carignane
3 seedlings, V17 R6 B2 x Terret Monstre

In 1915 much greater hybridization success was had. A large collection of seeds was secured and though many of these failed to germinate, seventy true hybrids have been propagated. The following *Euvitis* varieties are represented in the parentage of these hybrids:

AUTHENTIC HYBRID BETWEEN EUROPEAN AND MUSCADINE GRAPE

It is so difficult to hybridize Muscadine grapes with European grapes that doubt has often been cast on the genuineness of some of the alleged hybrids. This photograph shows that there can be no doubt about the hybrid nature of those secured by the U. S. Department of Agriculture. The hybrid shows its *rotundifolia* parentage by simple tendrils, leaf texture, and stem, and its *vinifera* parentage by forked tendrils, leaf lobes and variable size of leaf-serrations. Other characters are more or less intermediate. (Fig. 18.)

Muscat of Alexandria	Huasco
Calabrian	Winchell
Ferrara	Goethe
Rodites	Brilliant
Semillon	Catawba
White Hanepoot	Iona
Prune de Cazouls	Ives

In 1916 a still larger crop of hybrid seeds was secured from breeding work, and is now being grown.

The Department's success in producing Muscadine-Euvitis hybirds is attributable to the perfecting of methods, the use of varieties of greatest congeniality, and the selection of healthy, vigorous vines as parents. Of the commercial varieties of Muscadines, Thomas seems most congenial to *Euvitis* pollen. A number of the Department's seedling varieties, however, are even more readily hybridized. Certain *Euvitis* pollens can be more successfully used than others. These lines of congeniality have been established by experience. In hybridizing, only Muscadines have been used as the female parent; because of their dioeciousness, and because *Euvitis* pollen can be shipped more successfully than Muscadine pollen. *V. vinifera* pollen has been collected in the Department's experiment vineyards at Oakville and Fresno, Cal., by associates and mailed to Willard, N. C., where it was used in hybridization work after testing to prove its viability. Other *Euvitis* pollens have been collected at the Department's experiment vineyard at Vineland, N. J., and mailed to Willard for use.

While the hybrids have not yet fruited, it is an important result of breeding work to be able to say that *Muscadinia* x *Euvitis* hybrids are being secured in quantity. The hybridity is conclusively proved by their possession

of botanical characters of both *Muscadinia* and *Euvitis* as, for example, in the case of the tendrils. The *Muscadinia* species always have simple tendrils and the *Euvitis* always forked tendrils, while the hybrids generally have simple and forked tendrils on the same shoot. In like manner, the hybirds have both continuous and discontinuous pith, etc. It is expected that the first hybrids will leave much to be desired, but in a large collection a few valuable individuals may be found which, when again crossed with the best Muscadine or *Euvitis* varieties, will yield satisfactory results.

While improvement is expected from the Muscadine hybrids with native grape species, the greatest results are expected from the hybrids with the European grape, *V. vinifera*, because the latter varieties are strong in those characters in which the Muscadines are deficient, and weak only in the characters well developed in the Muscadines. For example, *V. vinifera* is very high in sugar but low in acid content, while the Muscadines are high in acid content but low in sugar. The native American *Euvitis* species, while having a higher sugar content generally than the Muscadines, are like the latter in their high acid content.

SUMMARY

The Muscadine grape breeding of the U. S. Department of Agriculture[7] is centered in a coöperative experiment vineyard located on the North Carolina State Department of Agriculture's Test Farm, Willard, N. C. Here pollination, culture, handling, marketing, and utilization problems have also been under investigation. Special emphasis has been given to pruning, training, and pollination studies, but the breeding investigations have occupied first place.

It is believed that with the achievment of the results from breeding work for which the Department is striving, togéther with the development of improved methods of growing, handling, and utilizing the fruit, the Muscadine grape industry will take a leading position among the fruit industries of the South and will afford a profitable means of utilizing a portion of the vast areas of cut-over pine lands of the Southeast.

Peculiarities of Conformation in Singers

As the conformation of those parts of the head used for singing is inherited, it is natural to suppose that singing ability is largely dependent on heredity. Dr. Irving Wilson Voorhees, who writes in the July issue of *Medical Review of Reviews*, gives some details about the peculiarities of conformation which show why training alone cannot produce a singer.

"I have studied the noses and throats of several of the great singers," he says, "and in each and every case can say that there was something remarkable about the formation of the nasal chambers or vocal cords or general muscular development of the chest. It is not always possible to tell what a voice is by a physical examination, but many times one can make a fair guess at it. The tenor's vocal cords, for instance, are likely to be short and thick; the basso's, long and flat. Like differences hold good for female voices. I am told by a physician who has examined Caruso that he has a broad roof to the mouth, a large nasopharynx, very roomy nasal resonators, and short, thick vocal cords with knife-like edge."

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[7] The progress of the Department's work with the Muscadine grapes has been reported in the reports of the Chief of the Bureau of Plant Industry and in the following bulletins:

Bulletin 273, Bureau of Plant Industry, The Muscadine Grapes.
Farmers' Bulletin 709, U. S. Department of Agriculture, The Muscadine Grapes.
Farmers' Bulletin 758, U. S. Department of Agriculture, Muscadine Grape Sirup.
Farmers' Bulletin 859, U. S. Department of Agriculture, Home Uses for Muscadine Grapes.

SELECT ARMY AVIATORS BY TEST, NOT BY EDUCATION

ROSWELL H. JOHNSON, *University of Pittsburgh*

THE work of an aviator is notoriously hazardous. In spite of this fact, the Government, instead of contenting itself with a minimum requirement for aviation, has in accordance with the following quotations directed that a college education shall be requisite.

The office of the Chief Signal Officer, War Department, authorizes the following:

The following instructions relative to the determining of educational qualifications of applicants for commission in the aviation section of the Signal Officers' Reserve Corps are announced:

Paragraph 10, Special Regulations No. 50, Aviation Section, Signal Corps, 1917, prescribes in line 7, "The mental examination may be omitted, but the equivalent of a college education will be required."

Line 14, paragraph 13, of the same order prescribes, "The applicant will be required to establish the fact that he has the equivalent of a college education."

The Chief Signal Officer of the Army directs me to inform you that the following will govern in determining whether or not an applicant possesses the required educational qualifications:

(*a*) The applicant must have completed a course at a recognized college or technical school or have the equivalent of such an education. In determining this equivaent consideration will be given to the applicant's intelligence, business or other training, travel, tutoring, home study, activity, and military training. In all cases the applicant must have completed a course at a high school or preparatory school of good standing. In each case the examining board must use discretion and judgment as to whether the applicant possesses the requisite training and judgment to enable him to perform the duties of a commissioned officer in the aviation section.

Roughly, of course, a college education indicates that an individual must belong to a certain mental grade of intelligence to have survived the process, but the qualifications necessary for an aviator are not those necessary to have survived a college education. To consider these qualifications, what can we do better than to examine the men who have been successful motorcycle and automobile racers? We suggest to the Government that psychological tests upon men who have been successful along these lines will give them what they want, coupled with the tests on the sense of equilibrium and control which are being employed. To use a college education fails to make the discrimination the Army desires, and it brings into this dangerous profession a number of men who are not needed, or who are needed in other work to a greater degree. It seems axiomatic that the nation should strive to pass through a war with the minimum loss in quality and quantity of its members. This, then, demands a far more careful selection of candidates.

We believe that the same reasoning applies in the matter of officers in the Infantry and Cavalry. The qualities here called for are better represented in men who have proved successful as foremen, than in those who are college graduates, many of whom will be ludicrous failures in the handling of men, and yet have other qualities far too valuable to waste in service to which they are not well adapted. If mental tests are to be used in the selection of officers, these tests should not be those of general intelligence but rather specially made out for those peculiar qualifications which are desirable in an army officer—in other words, what the psychologist calls a differential mental test, rather than a general one.

COLOR INHERITANCE IN MAMMALS

III. The Rat—Few Variations of Factors Known until Recently—Castle's Selection Experiment—Any Interpretation of It Demonstrates the Efficacy of Darwinian Selection

SEWALL WRIGHT
Bureau of Animal Industry, Washington, D. C.

UNTIL recently rats were relatively poor in known color varieties. Blacks, albinos and hooded blacks and grays were the only varieties known besides the wild gray color. Three recessive Mendelian factors, called here S_h, C_a and a, were demonstrated early by the work of Bateson,[1] Doncaster,[2] MacCurdy and Castle,[3] and others. These obviously are variations of a similar nature to piebald, albinism and black (or rather loss of agouti pattern) in mice and are to be assigned to classes $1a_2$, 1b and $2a_1$, respectively.

In 1914, Castle[4] reported on two new variations which had appeared independently as sports among wild rats in England. They are of rather similar apperance, the gray color of the wild rat in both cases being changed to a yellow, in which, however, the base of the hair is a pale slaty color. When the agouti factor is replaced by a, the entire fur is of this pale slaty color. The only distinct difference between the two variations is that in one the eyes are reduced to pink, in the other merely to a dark red. Both of them behave as simple recessives. In spite of their great similarity in effect Castle found them to be independent variations, reproducing a gray only a little less intense than the wild gray when crossed together. In fact, it was found difficult to get them into the same gamete and Castle and Wright[5] reported on a very high degree of linkage between them. Castle[6] further found indications that both of them are linked with albinism. This would be of very great interest if confirmed by further work in view of the probable linkage between albinism and the pink-eyed factor p of mice in the data of Darbishire and Cuénot. The pink-eye factor of mice is the nearest homologue of the pink-eye factor of rats. Both reduce black to a pale slaty brown in the fur, and nearly eliminate it in the eye but do not affect yellow. In agoutis there seems also to be some widening of the agouti band, due to the weakening of the black.

Gray Rat—S C A R P (Pattern of black and yellow)

$1a_1$	—	
$1a_2$	S, S_m, S_h	S_m white-bellied gray, S_h hooded gray.
$1a_3$	—	
1b	C, C_r C_a	C_r red-eyed dilute gray (sepia and white), C_a albino.
$2a_1$	A, a	a black.
$2a_2$	—	
$2a_3$	—	
2b	R, r	r red-eyed yellowish gray (very dilute black and intense yellow).
	P, p	p pink-eyed yellowish gray (very dilute black and intense yellow).

Thus the appearance of the red-eyed and pink-eyed agoutis is practically yellow. Both factors, however, must be placed in class 2b as being more similar in their action to the brown and pink-eyed colored variations of other

[1] Bateson, W. 1903. *Proc. Zool. Soc.*, 2:71–78.
[2] Doncaster, L. 1905. *Proc. Camb. Phil. Soc.*, 13:215–227.
[3] MacCurdy, H., and Castle, W. E. 1907. *Carn. Inst. Wash. Pub. No.* 70, 50 pp.
[4] Castle, W. E. 1914. *Amer. Nat.*, 48:65–73.
[5] Castle, W. E., and S. Wright, 1915. *Sci. N. S.*, 42:193–195.
[6] Castle, W. E. 1916. *Carn. Inst. Wash. Pub. No.* 241, part iii:161–187.

rodents than to recessive yellows such as found in guinea-pigs or rabbits.

A very different kind of dilution of coat and eye color in rats was discovered by Whiting.[7] In his red-eyed dilute rats, the yellow of the agouti band is reduced entirely to white, while the black is relatively little affected. He pointed out its very similar character to the red-eyed dilution of guinea-pigs and tests, which he made, soon showed that it is also genetically similar in being an allelomorph of albinism. As in guinea-pigs, he found it to be imperfectly dominant over albinism, but recessive to the intense color of wild grays. It is, of course, to be placed in class 1b.

THE HOODED PATTERN

Probably the most interesting experiments with rats are those dealing with the hooded pattern. This pattern is much less apt to be asymmetrical than the piebalds in most other mammals. Its variations can be arranged practically in a single linear series. White first appears in small patches on the feet and belly, creeps up the sides until the typical hooded pattern is reached—a black head and narrow mid-dorsal stripe, then obliterates the latter and gradually reduces the black on the head. Doncaster recognized four kinds of rats with regard to pattern—self, Irish a, Irish b, and hooded. The Irish rats are nearly self with white on the belly. He found that hooding was a clear-cut recessive to the others but that the Irish rats were of two sorts genetically. Some of them (class a) bred essentially like self rats, never producing piebalds. In these the ventral white appeared to be a fluctuating variation independent of the hooding. Other Irish rats (class b), usually with more ventral white than class a, produced 50% hooded rats in crosses with the latter and were evidently heterozygotes between self or Irish a and hooding. Castle[8] obtained similar results and carried on a very extensive experiment on the effects of selection on the hooding pattern, the results of which have called forth a great deal of discussion. By long continued selection the means of a plus and minus series have been carried far beyond the extremes of variation in the original stock, approaching the condition of Irish rats on the one hand, and black-eyed white on the other. In the course of the experiment a big advance appeared suddenly in two rats of the plus series, and at once behaved as a unit Mendelian dominant to the stock from which it rose. Rats from this source were called the mutant stock. Otherwise progress was very slow and uniform.

The results obviously have a most important bearing on the efficacy of selection in evolution, or in live-stock breeding operations. Most discussion, however, has centered on the interpretation of the means by which selection has worked. There are really two problems here. It has been widely held that new variations are so rare that they can virtually be neglected in interpreting such an experiment.[9] On this view, selection has worked merely by sorting out favorable combinations of factors already present in the original stock. Professor Castle, on the other hand, has held that the results could only be explained satisfactorily on the view that minute variations occur frequently if not almost invariably in the production of germ cells. His idea of the powers of selection is thus in essential agreement with Darwin's. A second problem is on the nature of the genetic basis of the different grades of the hooded pattern. On any view, a large part of this variation is not genetic but merely developmental. This is shown by the low correlations between parent and offspring. The weighted average is +.23 in plus series and +.18 in minus series for sixteen and seventeen

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[7] Whiting, P. W. 1916. *Sci. N. S.*, 43:781.

[8] Castle, W. E. 1912. *Amer. Breed. Mag.*, 3: 270–282. 1915. *Amer. Nat.*, 49: 37, 49: 713–726. 1916. *Loc. cit.* 1917. *Amer. Nat.*, 51: 102–114. Castle, W. E., and J. C. Phillips. 1914. *Pub. Carn. Inst. Wash.* No. 195, 56 pp.

[9] See for example, Muller, H. J. 1914. *Amer. Nat.*, 48:567. MacDowell, E. C., 1916. *Amer. Nat.*, 50:719–742.

generations respectively. The variations with a genetic basis may be due either to variations of the main hooding factor S_h in which case the different grades should be allelomorphs of each other (except for the non-genetic variation) or to the coöperation of independent factors with the hooding factor. Those who hold to an exceedingly stable germ-plasm must adopt the second view, at least in the main, to account for the success of selection. If, however, selection has worked through the appearance of numerous small variations these might be of either kind. Professor Castle has pointed out both possibilities and, indeed, has proved that both kinds of variations exist in particular cases. He attributes, however, more weight to variations of the main factor than to independent ones. The writer is inclined to reverse the emphasis.

ANALYSIS OF THE DATA

A rough analysis of the data on the assumption that both kinds of variations exist yields some very interesting results. Let it be assumed that the factor S is varying and that each generation or stock has its characteristic mean allelomorph in the series, which may be represented by S_{10+}, S_{10-}, S_W, S_M, S_I, etc., for the tenth plus and tenth minus generations and the wild, mutant and Irish stocks, respectively. Assume also that there is a large array of independent factors with respect to which each generation and stock has a certain average condition which may be represented by Σ_{10+}, Σ_{10-}, Σ_W, Σ_M, Σ_I, etc. Assuming variation to occur at random in both directions, a given factor as S_{10+} should come out of any cross at the same average level, S_{10+}, that it went in. Justification of this assumption may be found in the crosses of the tenth plus generation with the mutant rats spoken of above which came from this generation. The tenth plus generation were of an average grade of +3.73 on Professor Castle's scale in which +6 is self and −4 a nearly solid white with only a little black on the head. The mutants were about grade +5.50 but in F_2 or later generations of the cross of tenth plus with mutant the hooded segregates averaged very close to +3.73 (actually +3.79) showing that in a cross in which the same independent factors should be present in both parents, the hooding factor segregates out unchanged after a generation in nearly self rats. In regard to the independent factors, the best working assumption for the average produced by any cross or back cross seems to be blending inheritance. Thus F_1 from tenth plus (grade +3.73) by tenth minus (grade −2.01) was +1.00 in grade, about half way between the parents, and F_2 averaged nearly the same, +0.73, although with somewhat greater variability showing slight indications of segregation. The standard deviations were +0.60 and +0.87 in F_1 and F_2 respectively. This cross would be presented by the symbols above as follows:

$$S_{10+}S_{10+}\Sigma_{10+} \times S_{10-}S_{10-}\Sigma_{10-}$$
$$= S_{10+}S_{10-}\ \frac{\Sigma_{10+}+\Sigma_{10-}}{2}$$

In F_2 there should be segregation of S_{10+} and S_{10-} but the *average* condition of the independent factors should still be $\frac{\Sigma_{10+}+\Sigma_{10-}}{2}$.

By this method it is possible to deduce roughly the average grade of rats which have derived their hooding factor from one source and the entire array of independent factors from another. Thus F_1 from the cross mutant by tenth minus must be $S_MS_{10-}\frac{\Sigma_M+\Sigma_{10-}}{2}$ and the easily recognized hooded rats in F_2 must on the average be of formula $S_{10-}S_{10-}\frac{\Sigma_M+\Sigma_{10-}}{2}$. But this is the same as F_1 between minus and a hypothetical stock with the main hooding factor of the tenth minus generation, but the residual heredity of the mutant stock, $S_{10-}S_{10-}\Sigma_M$. The F_2 segregates from the cross tenth minus with mutant, then, should be just half-way between the tenth minus and the hypothetical stock in grade, which enables us to deduce the grade of the latter. The following table is thus derived from crosses given by Castle

between various generations of hooded stock and the mutant, wild and Irish stocks respectively. In interpreting the results, the strength or weakness of the various assumptions made must, of course, be born in mind.

From table[10]	Source of recessives	No. of rats	Mendelian formula of extracted recessives	Grade in selection experiment	Grade in extracted recessives	Deduced grade with residual heredity of mutant, wild or Irish stock
55	F_2 from mutant × minus ($F_1 = S_M S_{10}-$)	14	$S_{10}-S_{10}-$	$\Sigma_{10}-$ -2.01	$\Sigma_{10}-+\Sigma_M$ $+0.75$	$\Sigma_M+3.51$
51	F_1 from mutant × plus	58	$S_{10}+S_{10}+$	$\Sigma_{10}+$ $+3.73$	$\Sigma_{10}++\Sigma_M$ $+3.73$	$\Sigma_M+3.73$
53	F_1 and F_2 mutant × mutant	8	$S_{10}+S_{10}+$	$\Sigma_{10}+$ $+3.73$	$\Sigma_{10}++\Sigma_M$ $+3.75$	$\Sigma_M+3.77$
51, 53, 54	Total mutant × plus crosses	136	$S_{10}+S_{10}+$	$\Sigma_{10}+$ $+3.73$	$\Sigma_{10}++\Sigma_M$ $+3.76$	$\Sigma_M+3.79$
42	F_2 from wild × minus	91	$S_{10}-S_{10}-$	$\Sigma_{10}-$ -2.01	$\Sigma_{10}-+\Sigma_W$ $+0.24$	$\Sigma_W+2.48$
42	F_2 from wild × minus	48	S_6-S_6-	Σ_6- -1.56	$\Sigma_6-+\Sigma_W$ $+0.25$	$\Sigma_W+2.06$
42	F_2 from wild × minus	62	$S_{2\frac{1}{2}}-S_{2\frac{1}{2}}-$	$\Sigma_{2\frac{1}{2}}-$ -1.13	$\Sigma_{2\frac{1}{2}}-+\Sigma_W$ $+0.31$	$\Sigma_W+1.74$
42	F_2 from wild × plus.	21	S_3+S_3+	Σ_3+ $+2.51$	$\Sigma_3++\Sigma_W$ $+2.56$	$\Sigma_W+2.61$
42	F_2 from wild × plus.	38	$S_{5\frac{1}{2}}+S_{5\frac{1}{2}}+$	$\Sigma_{5\frac{1}{2}}+$ $+3.00$	$\Sigma_{5\frac{1}{2}}++\Sigma_W$ $+2.97$	$\Sigma_W+2.94$
42	F_2 from wild × plus.	16	$S_{10}+S_{10}+$	$\Sigma_{10}+$ $+3.73$	$\Sigma_{10}++\Sigma_W$ $+3.15$	$\Sigma_W+2.57$
141[11]	F_2 from wild × plus.	73	$S_{11}+S_{11}+$	$\Sigma_{11}+$ $+3.78$	$\Sigma_{11}++\Sigma_W$ $+3.17$	$\Sigma_W+2.56$
141[11]	F_2 from F_2 (wild × plus) × plus	256	$S_{11}+S_{11}+$	$\Sigma_{11}+$ $+3.78$	$\Sigma_{11}+$ $+3\Sigma_W$ $+3.34$	$\Sigma_W+3.19$
43	F_2 from Irish × minus	66	$S_{7\frac{1}{2}}-S_{7\frac{1}{2}}-$	$\Sigma_{7\frac{1}{2}}-$ -1.77	$\Sigma_{7\frac{1}{2}}-+\Sigma_I$ -0.94	$\Sigma_I-0.11$
43	F_2 from Irish × minus	53	S_4-S_4-	Σ_4- -1.28	$\Sigma_4-+\Sigma_I$ -0.73	$\Sigma_I-0.18$
43	F_2 from Irish × minus	90	$S_{3\frac{1}{2}}-S_{3\frac{1}{2}}-$	$\Sigma_{3\frac{1}{2}}-$ -1.23	$\Sigma_{3\frac{1}{2}}-+\Sigma_I$ -0.62	$\Sigma_I-0.01$
43	F_2 from Irish × plus	239	S_2+S_2+	Σ_2+ $+1.92$	$\Sigma_2++\Sigma_I$ $+1.27$	$\Sigma_I+0.62$
43	F_2 from Irish × plus	23	S_3+S_3+	Σ_3+ $+2.51$	$\Sigma_3++\Sigma_I$ $+0.95$	$\Sigma_I-0.61$

From the table it appears that with a given residual heredity the main hooding factors derived from the plus and minus series produce but little difference in effect. Thus, finding the weighted average for hooded rats derived from the plus and the minus strains when associated with the residual heredity of the mutant, wild and Irish stocks, respectively, we get the following results:

Source of hooding factor	*Residual heredity* *Mutant*	*Wild*	*Irish*
Plus	+3.79	+2.99	+0.51
Minus	+3.51	+2.15	−0.08
Difference	+0.28	+0.84	+0.59

It appears that residual heredity the Irish and wild rats seems very clear. This suggests that Irish rats may possess the same hooding factor as wild rats, but owe their white bellies to minus selection or, more likely, to crossing with hooded rats which had been selected in a minus direction.

In the case of the mutant rats, however, there would seem to be no room for doubt that we are dealing with a real variation of the hooding factor intermediate between the level in wild or Irish rats and that in hooded rats. The mutants look like Irish rats in having white on the belly but breed very differently. They possess the residual heredity of the plus selection series

[10] Castle, W. E., and Phillips, J. C. 1914. *Loc. cit.*
[11] Castle, W. E. 1916. *Loc. cit.*

from which they sprang, which is at a distinctly higher level than that of the wild stock and at a very much higher level than that of the Irish. With the residual heredity of the minus selection series they would doubtless look like ordinary hooded rats. There remains one possible different interpretation. Mutants may differ from their hooded ancestors by a factor which is wholly independent of that present in wild rats. Symbolically, hooded rats may be S_hS_hmm, mutants S_hS_hMM, while wild rats are SSmm. Castle has, however, virtually eliminated this possibility by crossing wild with mutant and raising an F_2. On the hypothesis of independence 6% hooded rats should appear in F_2 but among forty-six individuals none such appeared.

Thus genetic variations of the hooding factor and ones independent of it are both present to give a basis for selection. The origin of the mutants in the course of the experiment, of course, demonstrates that there is no absolute stability of the germ plasm. Further, where there is one variation which is of great enough effect to be recognizable at once, many more smaller should perhaps be expected. Whether the selection actually has progressed largely through favorable combinations of factors or through the occurrence of small mutations is not easy to answer. MacDowell has cited the decrease in the standard deviation as evidence that each selection series is becoming more nearly homozygous. It is, however, not certain that a grade near the extremes of the series means exactly the same thing as near the middle. The fact that the correlation between parent and offspring shows actually a slight increase as selection progresses indicates that the ratio of genetic to somatic variation has not suffered and argues for the frequent occurrence of new variations. These may, of course, be largely independent of the hooding factor in inheritance. It should be added that the large amount of somatic variation and the absence of close inbreeding make it highly improbable that the parent-offspring correlation can be due to a splitting up of each selection series into non-interbreeding groups, even though there is assortative mating.

Summing up, it appears most probable to the writer that genetic variations are occurring sufficiently often to give a basis for selection to an indefinite extent. Most of such variations seem to be inherited independently of the hooding factor, but at least in one case it has been demonstrated exhaustively that the hooding factor itself has varied to a new level in the direction of its allelomorph in wild rats.

Conditions are doubtless more or less similar in other piebald animals. In most cases, however, the variability due to irregularity in development is greater than in the rat. This is notably the case in the guinea-pig in which the pattern remains exceedingly variable after generations of the closest inbreeding. Yet in a stock breeding at random the correlation between parent and offspring is about the same as in rats. Perhaps the irregularity in development argues a genetic instability from which even the germ cells are not exempt.

Finally, under any interpretation, Castle's selection experiment demonstrates the efficacy of Darwinian selection. It is true that one large mutation occurred with effects perhaps as large by itself as the entire plus selection series, but where such a variation gives one new level, selection has produced a continuous series of stable levels. This would give selection of small variations a more important place in evolution and animal husbandry where it is nice adjustments of one character to another or to the environment that count.

PITCHER-LEAVED ASH TREES

The above photograph shows a leaf of an ash tree (*Fraxinus americana*), grown from seeds of a similar tree found in 1904 near the Station for Experimental Evolution, Cold Spring Harbor, Long Island. It will be noted that several of the leaflets form little conical cups. Such leaves are known as ascidia or, popularly, "pitchers."

As stated in *Science*, May 18, 1917, trees of this type were supposed to grow only at Cold Spring Harbor, until their discovery last summer at two points in eastern Pennsylvania. In order to determine the probable evolutionary history of these trees it is necessary to know their present geographical distribution. Are they the result of recent mutations, or the remnants of an older, more widely distributed form?

The peculiar form of the leaflets is so readily observed, particularly on young trees, that I hope the readers of this journal will make note of their observations and communicate the results to me. Anyone who is willing to assist in this study should examine all the ash trees accessible to him, and let me know approximately the area covered by the observations, and the number of *normal* ash trees observed, as well as the number of pitcher-leafed trees, if any. It is just as important for the purpose of this study, to know that pitcher-leafed trees do *not* occur in a given locality as to know that they do. (Fig. 19.)

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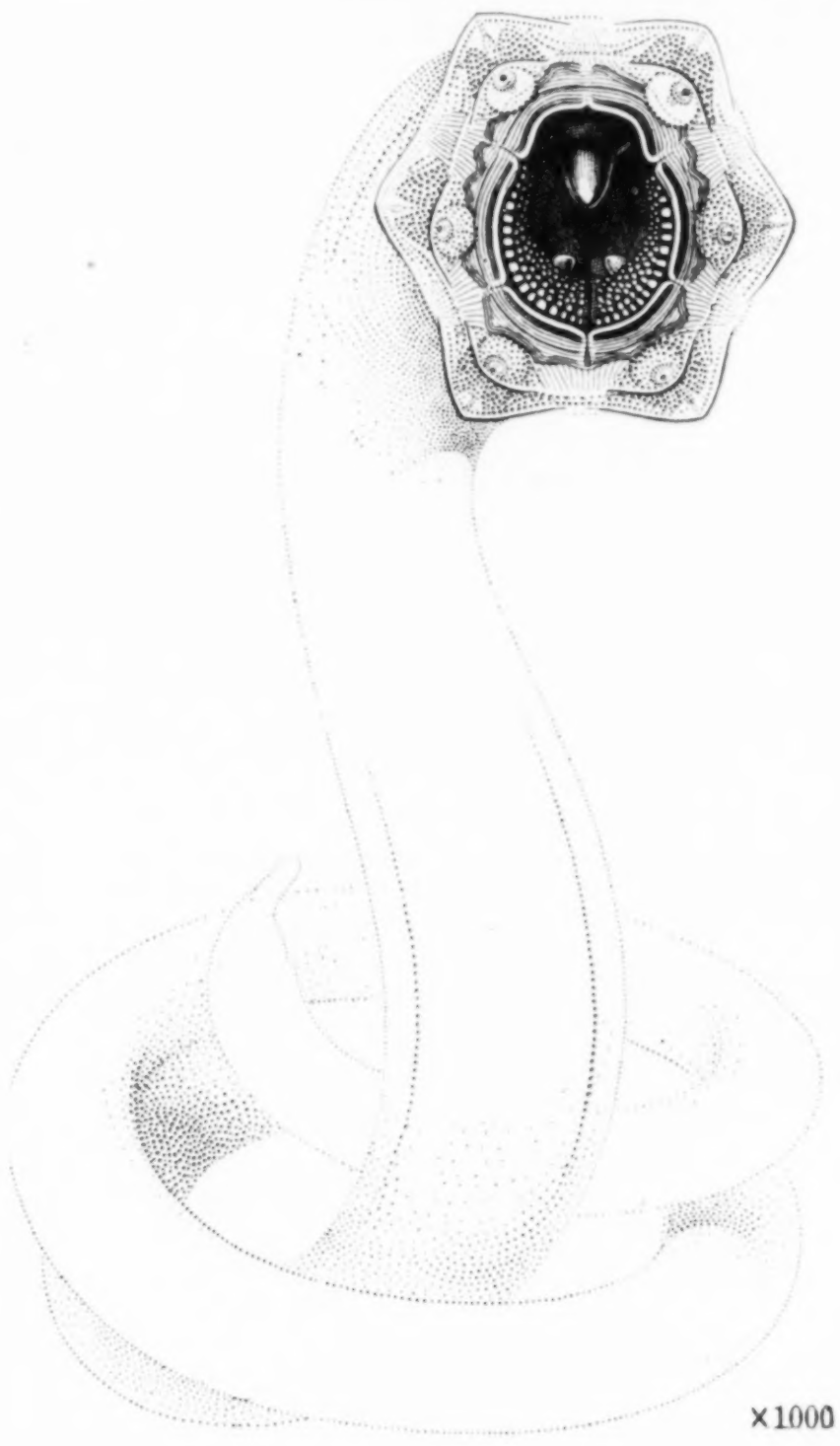
THE DISAPPEARANCE OF THE MALE MONONCH

OF ALL the nematodes or thread-worms, few are more common than the Mononch. Its microscopic size conceals its abundance. Hundreds of millions of them may be found in a single acre of garden soil. Dirt is usually thought of as dead matter, but to a magnifying eye it would appear to be almost alive, a squirming mass of micro-organisms, abundant among which would be the Mononchs, benefiting the agriculturist by rapaciously destroying many other nematodes and micro-organisms that injure plants.

The remarkable sexual history of these nematodes is described by N. A. Cobb (Contributions to a Science of Nematology, VI, *Soil Science*, May, 1917). In most mononchs males are either nonexistent or else so rare as to be negligible, a single one occurring perhaps among several thousand females. In these circumstances, the male has ceased to play an important part in reproduction, and the female has developed the capacity to produce sperm and ova in the same organ—a condition that Dr. Cobb calls syngonism. Early in her life the female produces a quantity of spermatozoa, which are stored away by her. Later the female sexual characters develop and she produces ova, which are fertilized by her own, exceedingly minute spermatozoa. In some nematodes the spermatozoön seems merely to give a stimulus to the egg, which then develops parthenogenetically; but in those studied by Dr. Cobb it seems likely that there is a real fusion of the two sex-cells, which, therefore, probably differ in the same way that the male and female reproductive cells of other animals do. It is possible, Dr. Cobb suggests, that in other animals where the ovum is thought to develop without fertilization, it may, in reality, be fertilized by a very minute, hitherto overlooked spermatozoön produced by the female herself, just as in the case of the Mononch.



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A MONONCH

Garden soil is full of microscopic thread-worms like this. The head of the specimen here figured is accurate in every detail; the body is somewhat posed. Its mouth is wide open, showing its prominent single fang. It feeds on other thread worms. From a drawing by W. F. Chambers. (Fig. 20.)

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THE annual reports of the AMERICAN BREEDERS' ASSOCIATION, published in seven volumes, form the most valuable collection of material for students of genetics which has been published in the United States. Most of them are out of print and are becoming expensive. All of them are nearly indispensable to libraries, institutions and students of plant and animal breeding, heredity, variation, eugenics, or genetics in general.

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